UNITED STATES ARMY IN WORLD WAR II

Special Studies

MANHATTAN:
THE ARMY AND THE ATOMIC BOMB

by
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CENTER OF MILITARY HISTORY
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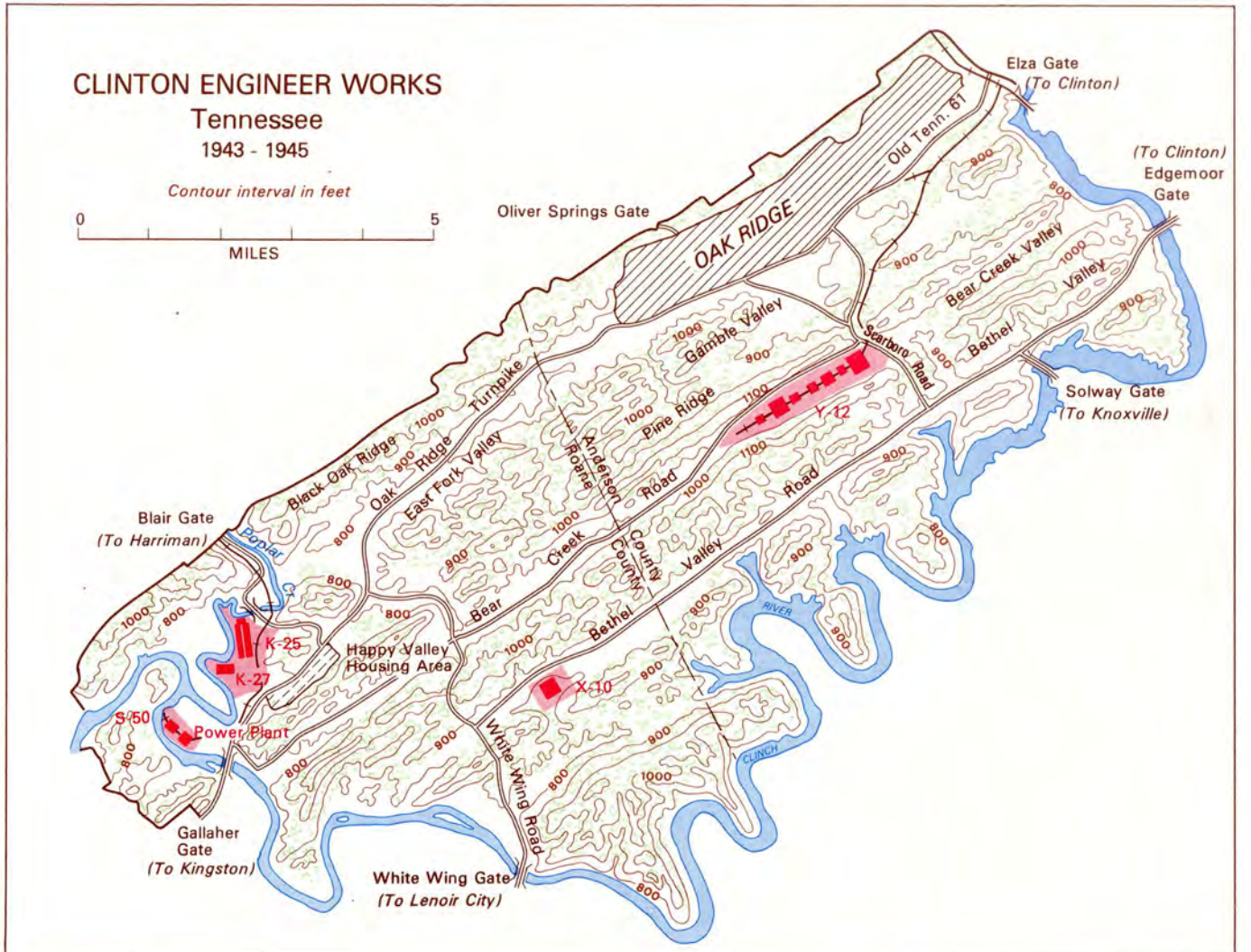
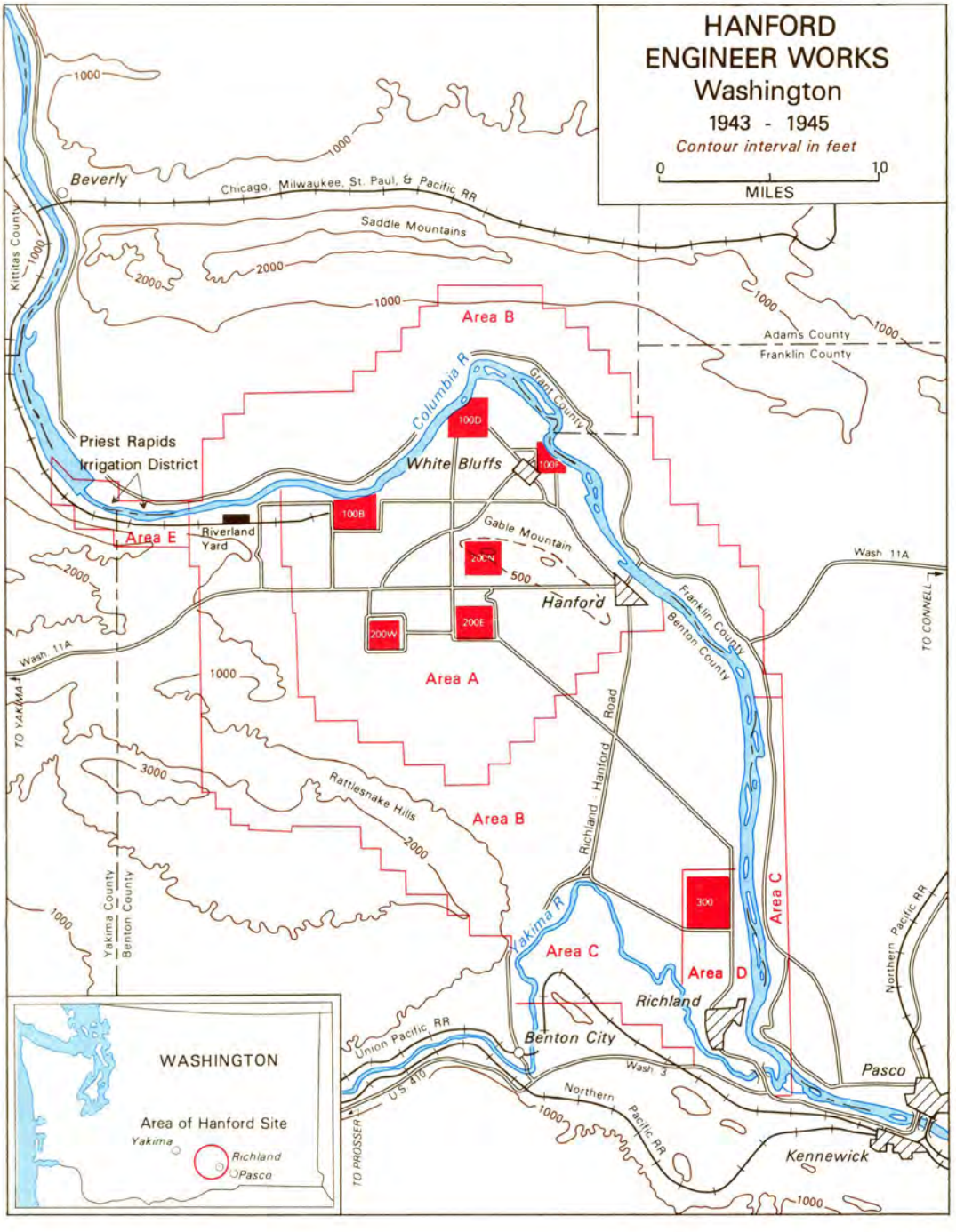
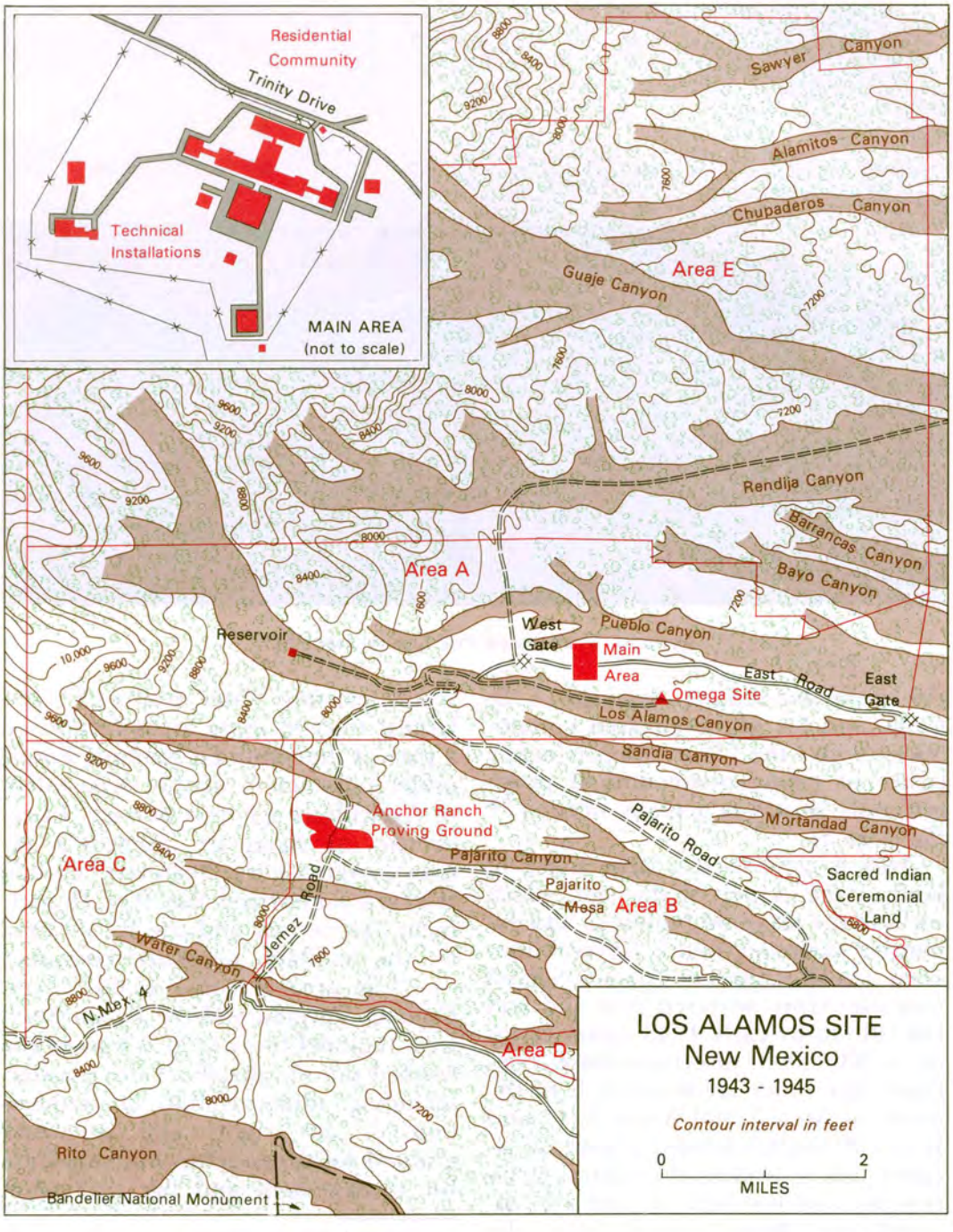

CLINTON ENGINEER WORKS
Tennessee
1943 - 1945
Contour interval in feet
0
5
MILES
Oliver Springs Gate
OAK RIDGE
Old Tenn. 61
Elza Gate
(To Clinton)
(To Clinton)
Edgemoor
Gate
Bear Creek Valley
Bethel Valley
Scarboro Road
Solway Gate
(To Knoxville)
Gamble Valley
Pine Ridge
Y-12
Turnpike
Black Oak Ridge
Oak Ridge
East Fork Valley
Roane Anderson
Bear Creek
County Road
Bethel Valley Road
Blair Gate
(To Harriman)
Poplar
K-25
K-27
S-50
Power Plant
Happy Valley
Housing Area
X-10
White Wing Road
Gallaher
Gate
(To Kingston)
White Wing Gate
(To Lenoir City)
CLINCH RIVER

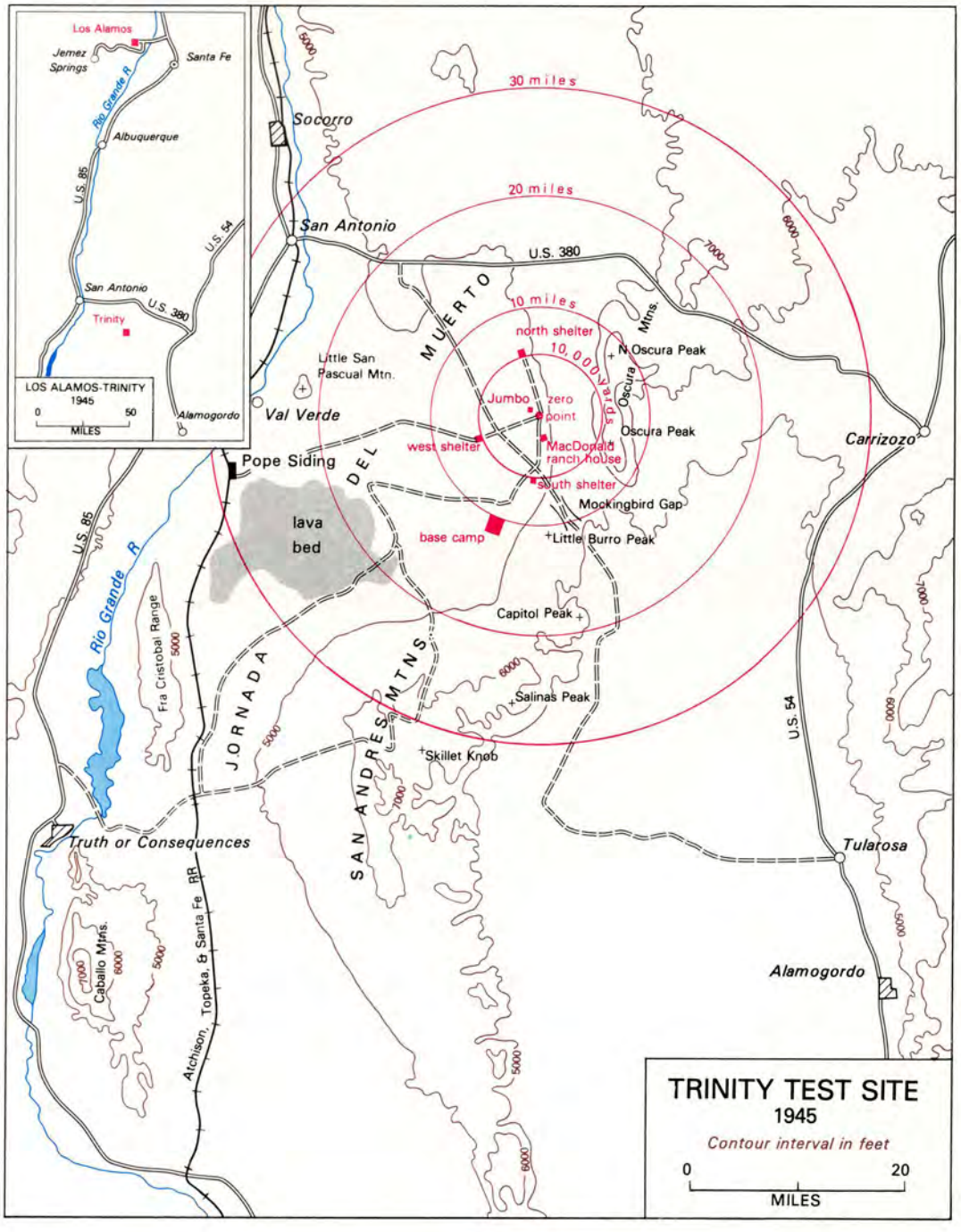
MAP 3


HANFORD
ENGINEER WORKS
Washington
1943 - 1945
Contour interval in feet
0
10
MILES
Beverly
Chicago, Milwaukee, St. Paul, & Pacific RR
Saddle Mountains
Kittitas County
Adams County
Franklin County
Grant County
Columbia R
Area B
Priest Rapids
Irrigation District
White Bluffs
100D
100F
100B
Area E
Riverland
Yard
Gable Mountain
200N
500
Hanford
200W
200E
Area A
Wash 11A
TO YAKIMA
TO CONNELL
Franklin County
Benton County
Richland Hanford Road
Rattlesnake Hills
Area B
Yakima County
Benton County
Yakima R
Area C
300
Area D
Richland
Area C
Northern Pacific RR
Union Pacific RR
Benton City
Wash 3
US 410
Pasco
Northern Pacific RR
TO PROSSER
Kennewick
WASHINGTON
Area of Hanford Site
Yakima
Richland
Pasco

MAP 4


Residential
Community
Trinity Drive
Technical
Installations
MAIN AREA
(not to scale)
Sawyer Canyon
Alamitos Canyon
Chupaderos Canyon
Guaje Canyon
Area E
Rendija Canyon
Barrancas Canyon
Bayo Canyon
Area A
Reservoir
West
Gate
Pueblo Canyon
Main
Area
East Road
East
Gate
Omega Site
Los Alamos Canyon
Sandia Canyon
Anchor Ranch
Proving Ground
Pajarito Road
Mortandad Canyon
Pajarito Canyon
Area C
Jemez Road
Pajarito
Mesa
Area B
Sacred Indian
Ceremonial
Land
Water Canyon
N.Mex. 4
Area D
Rito Canyon
Bandelier National Monument
LOS ALAMOS SITE
New Mexico
1943 - 1945
Contour interval in feet
0
2
MILES

MAP 5


Los Alamos
Jemez Springs
Santa Fe
Rio Grande R.
Albuquerque
U.S. 85
U.S. 54
San Antonio
U.S. 380
Trinity
LOS ALAMOS-TRINITY
1945
0
50
MILES
Alamogordo
Socorro
San Antonio
30 miles
20 miles
10 miles
U.S. 380
MUERTO
DEL
Little San Pascual Mtn.
Val Verde
Pope Siding
lava bed
north shelter
10,000 yards
N. Oscura Peak
Oscura Mtns.
Jumbo
zero point
Oscura Peak
west shelter
MacDonald ranch house
south shelter
Mockingbird Gap
base camp
Little Burro Peak
Capitol Peak
Salinas Peak
Skillet Knob
Carrizozo
U.S. 85
Rio Grande R.
Fra Cristobal Range
JORNADA
SAN ANDRES MTNS.
U.S. 54
Truth or Consequences
Tularosa
Alamogordo
Caballo Mtns.
Atchison, Topeka, & Santa Fe RR
5000
6000
7000
TRINITY TEST SITE
1945
Contour interval in feet
0
20
MILES

MAP 6

CHAPTER XXV

Weapon Development and Testing

A watershed in the development of nuclear science was the Army's building and testing of the atomic bomb. In early 1943, with America engaged in what was believed to be a desperate race with Germany, American and foreign-born physicists, chemists, metallurgists, and engineers, as well as military technical experts, came together at Los Alamos to devise a weapon with a power hitherto unmatched by man. This practical objective melded with the larger scientific challenge of turning atomic theory into a material reality and resulted in a unity of purpose that sustained the assembled scientists in their unique atomic adventure.

Organized by Oppenheimer into specialized research and technical divisions and groups, the Los Alamos scientists divided their efforts between two fundamental tasks: solving the theoretical and experimental problems of a fission bomb,[1] and working out the complex ordnance and engineering problems of weapon design and fabrication. Their concentrated activity over a two-year period, from 1943 to 1945, transformed the laboratory, for all intents and purposes, into a weapon assembly and test plant. The climax was Project Trinity, the crucial test of their creation: the first atomic bomb.

Building the Bomb

By the fall of 1943, with the laboratory's administrative organization largely worked out and the scientists' talents and energies channeled into various research programs, Oppenheimer, Groves, Conant, and the other project leaders turned their attention to the problem of determining the most suitable design of an atomic device.[2] During inspection

[1] By late September 1943, Oppenheimer and his scientific staff definitely had decided to concentrate the laboratory's major resources on developing a fission bomb, relegating work on the "super" (or fusion) bomb to theoretical investigations by a small group of scientists under the leadership of physicist Edward Teller and then, in 1944, physicist Enrico Fermi. Both Groves and Richard C. Tolman, the Manhattan commander's chief adviser on weapon development, supported this action to carry on super bomb research even in the most hectic period of fission bomb development, primarily because they could not forget the known interest of the Germans in deuterium (heavy water)—the active material for the super bomb. See Groves Diary, 29–30 Sep 43, LRG; Groves, *Now It Can Be Told,* p. 158; Edward Teller and Allen Brown, *The Legacy of Hiroshima* (Garden City, N.Y.: Doubleday and Co., 1962), pp. 38–40; MDH, Bk. 8, Vol. 2, "Technical," pp. XIII.1–XIII.10, DASA.

[2] Except as otherwise indicated, the discussion on weapon development is based on MDH, Bk. 8, Vol. 2, pp. IV.1–VIII.32 and X.1–XVII.22, DASA, and Hewlett and Anderson, *New World,* pp. 240–54 and 310–21.

visits to Los Alamos, Groves found that some of the scientific staff members, including Captain Parsons, strongly favored the gun rather than the implosion principle as more feasible for developing a usable fission weapon. They pointed out that the well-established mechanical techniques of the gun made this weapon type almost certain to work if properly designed and that the design and engineering of the outer configuration and mechanics of the gun were already well advanced. Furthermore, once the physicists, chemists, and metallurgists could provide the precise nuclear specifications for the active material—whether U-235, Pu-239, or even U-233 from thorium—development of a workable gun-type weapon would be only a matter of time.

Assessment of precise nuclear specifications for a fission weapon was the responsibility of the laboratory's experimental physics division. Through intensive research, the division's physicists gathered considerable data on the effect of cosmic rays on fissioning, on measurement of nuclear cross sections, on scattering phenomena, and on other aspects of the fission process that related to bomb specifications and efficiency. With this data they were able to calculate by the summer of 1944 that the destructive effect of either an implosion- or gun-type bomb would justify the effort required to fabricate it. They still lacked an answer, however, to the question on which the success of the entire project hinged: How much fissionable material would be needed for an effective weapon? Whether or not atomic weapons would be available for use in the war depended on the answer to that question.[3]

One way to increase the efficiency of a fission bomb was to achieve maximum purity in the active materials. Hence, a major program of the laboratory's chemistry and metallurgy division was to improve the methods for purifying U-235 and Pu-239. Because purity requirements for uranium were about one-third less than those for plutonium and because, until early 1944, there was not enough Pu-239 available to permit effective work on its purification, the chemists experimented with uranium but with the purpose of developing techniques that might also be used with plutonium. When sufficient amounts of Pu-239 arrived from the Clinton pile, the chemists developed both wet and dry purification processes. Subsequently, they employed the more satisfactory wet process in final purification of most plutonium for the bomb.

Before U-235 or Pu-239 could be used in a fission bomb, they had to be converted into metal of the proper configuration and purity. Metallurgists at Los Alamos faced a number of problems in making uranium or plutonium metal of the desired quality, including the tendency of uranium to catch fire during processing and the difficulty of handling the highly reactive and poisonous plutonium. For forming uranium into metal, they experimented with electrolytic and centrifuge processes but finally settled upon a modification of the stationary

[3] MPC Rpt, 21 Aug 43, OCG Files, Gen Corresp, MP Files, Fldr 25, Tab E, MDR; ibid., 4 Feb 44, OCG Files, Gen Corresp, MP Files, Fldr 25, Tab C, MDR.

TECHNICAL AREA AT LOS ALAMOS, *built around Ashley Pond and along Trinity Avenue*

bomb method, devised earlier at Iowa State. For plutonium, the metallurgists were as handicapped as the chemists, with only microscopic quantities available. Fortunately, many of the methods they developed for uranium proved adaptable to plutonium. Again like the chemists, the metallurgists had to devote considerable effort to devising improved recovery methods so that virtually none of the precious metal would be lost in processing it for use in a weapon.[4]

While awaiting the physical and nuclear specifications for the active materials, the laboratory's ordnance division worked on the development and proving of the mechanical components for the first experimental guns. First priority was design and fabrication of a plutonium-projectile gun. This gun type posed more problems than a uranium gun, because of Pu-239's higher propensity to predetonation, but the division's theory that a gun with sufficient muzzle velocity to avoid predetonation with Pu-239 was certain to be suitable for U-235 justified the concentration of effort.

Using standard ordnance and interior ballistics data obtained from the National Defense Research Committee (NDRC), the ordnance division had its design engineers complete the drawings for a high-velocity gun and, with subsequent approval from the Navy's Bureau of Ordnance, ordered forgings for two guns from the Naval

[4] Ltrs, Groves to Oppenheimer, 19 Jun 44, and Oppenheimer to Groves, 27 Jun 44, Admin Files, Gen Corresp, 729.31, MDR; Ltr, Oppenheimer to Groves, 31 Aug 44, Admin Files, Gen Corresp, 400.17 (Mfg-Prod-Fab), MDR.

Gun Factory in Washington, D.C. In the meantime, while the guns were being manufactured, Captain Parsons arranged for construction of the Anchor Ranch Proving Ground, some 8 miles east of the central laboratory facilities, where, by September 1943, the division's proving ground group began testing and perfecting gun performance techniques on a limited and then increased basis.

By early 1944, gun research was advancing smoothly, despite a constant shortage of experienced personnel and difficulties in materials procurement. The division's design engineers had established the exact specifications of a low-velocity gun, to be used with U-235. Hence, because these specifications were considerably less stringent than previously anticipated for a U-235 gun, the engineers were able to reduce the original muzzle velocity requirements. This achievement made it possible for the division to place a March order with the Naval Gun Factory for three of these uranium guns, which was much earlier than expected and just days after the factory had delivered the first two plutonium prototypes to Los Alamos.[5]

Primarily because of the undeveloped state of the art, interest in implosion research for a time ranked second to that in gun assembly research. Since April 1943, physicist Seth H. Neddermeyer from the California Institute of Technology had been conducting laboratory experiments with high explosives, designed to test the feasibility of the implosion principle. Handicapped by the shortage of experienced personnel and by the general lack of enthusiasm for implosion among his colleagues, Neddermeyer's project had definitely remained a "dark horse" in the race for completion of a workable atomic device.

But all of this changed with the arrival of John von Neumann in midsummer 1943. The widely respected Hungarian-born mathematician from the Institute for Advanced Study at Princeton had been carrying out work on shock waves for the NDRC. Applying knowledge of explosives gained in his work with shaped charges, he theorized the likely effects of increasing the velocity of convergingly focused active material in the implosion bomb. His calculations convinced him that if the mechanical problems of achieving higher velocity could be solved, an implosion bomb would attain criticality using less active material of a considerably lower level of purity than hitherto believed possible. If he were correct, implosion offered a means to save precious months in developing a weapon—provided, of course, that ways could be devised to avoid predetonation and achieve symmetry in the imploding shock wave inside the bomb.

By early fall Oppenheimer, Groves, Conant, and the other project leaders were reevaluating implosion. Groves conferred with George B. Kistiakowsky, the distinguished Harvard chemist who was an expert on explosives, and with Oppenheimer and members of the laboratory's implosion study group. This led to a decision by Oppenheimer and the laboratory's governing board to expand the implosion

[5] Rpt, Parsons, sub: Summary of Ord Div, 15 Apr 44, OCG Files, Gen Corresp, MP Files, Fldr 19, Tab A, MDR; Memo, Tolman to (probably Groves), sub: Org of Ord Div at Y (Los Alamos), 1 Mar 44, OCG Files, Gen Corresp, MP Files, Fldr 25, Tab G, MDR.

program immediately, beginning with construction of an on-site plant for casting and trimming test components and installation of the unusual facilities required for testing implosion devices. In early November, Groves and Conant outlined the advantages of implosion to the Military Policy Committee. The following February, the committee informed the President that "there is a chance, and a fair one, if a process involving the use of a minimum amount of material proves feasible, that the first bomb can be produced in the late fall of 1944." [6]

Once project leaders had approved undertaking a major developmental program for the implosion bomb, General Groves began a full and objective analysis of the laboratory's organization, personnel, and facilities for carrying it out. Consulting with von Neumann and Parsons in Washington, D.C., he arranged to have Tolman visit Los Alamos for an extended period to investigate the program. Giving special attention to the laboratory's ordnance division, Tolman prepared a detailed analysis of its organization and activities, including estimates of the additional personnel that he believed the division would require to complete the implosion program. Tolman found that the laboratory had indeed made considerable progress toward shifting priority to implosion, although Oppenheimer was not yet prepared to abandon some further efforts on the almost certain-to-work plutonium gun.[7]

By the time of Tolman's visit, the inevitable shift in emphasis from research and experimentation to engineering, fabrication, and testing was already well under way. Construction crews, under direction of Maj. Wilber A. Stevens and partially comprised of men from the Provisional Engineer Detachment, had completed or were at work on a number of essential test areas (eventually there would be more than thirty of these). They had built a facility for casting containers for explosive charges at the Anchor Ranch Proving Ground and, less than a mile to the south, were well advanced on a much larger and more elaborately equipped area—designated S (for Sawmill) Site—with a laboratory, shops, powder magazines, and even a dining hall. In addition, Major Stevens's crews had begun work on several outlying sites required especially for testing various implosion devices. Special Engineer Detatchment (SED) troops provided a considerable part of the manpower operating these test sites.

Ordnance teams from Los Alamos also assembled and tested bomb components at test sites at Wendover Field (Utah), Inyokern (California), and Alamogordo Army Air Field (New Mexico). (*See Map 2.*) For these tests, the laboratory procured normal weapon components and high explosives from a variety of government and private suppliers—the Naval Gun

[6] Quotation from MPC Rpt, 4 Feb 44, MDR. See also Groves Diary, 20 and 29–31 Oct 43, LRG, and MPC Min, 9 Nov 43, OCG Files, Gen Corresp, MP Files, Fldr 23, Tab A, MDR.

[7] Memo, Tolman to Groves, sub: Rpt on Status of Ord Work at Y, 1 Mar 44, and attached report, OCG Files, Gen Corresp, MP Files, Fldr 25, Tab G, MDR; Groves Diary, 21 Jan, 22 Feb, and 2–3 Mar 44, LRG.

Factory in Washington, D.C.; the Naval Ordnance Plant in Centerline, Michigan; the Naval Depot in Yorktown, Virginia; the Expert Tool and Die Company in Detroit; the Hercules Powder Company in Wilmington, Delaware; the Monsanto Chemical Company in Dayton, Ohio, to name only a few. But for special parts and materials that were unobtainable, the laboratory itself had to function as an ordnance manufacturing plant. Best illustrating this concentration of effort was the major task of converting U-235 and Pu-239 into metal bomb components.[8]

In early 1944, the laboratory intensified procurement efforts for specialized equipment for implosion testing. In April, the IBM machines needed to speed up analysis of useful data from implosion tests arrived. And in July, the Military Policy Committee approved procurement of a huge solid steel receptacle for testing the first implosion device, thus ensuring recovery of the active material in the event of a fizzle. By then, implosion development had made giant strides, but still unknown were the relative efficiency of such a design and how long it would take to build a moderately effective implosion device.[9]

Despite frequent changes in the general specifications for an atomic weapon, the laboratory's ordnance division had worked out the design of two basic bomb models by the summer of 1944. The gun-type model, the "Thin Man," was about 10 feet in length, with a varying diameter of 1.5 to 2.5 feet, and had an estimated weight (when loaded) of 5 tons. The implosion-type model, the "Fat Man," was almost as long (9 feet) but thicker, tapering down from a hemispherical nose measuring 5 feet in diameter to a tailend of about 3 feet, and had an estimated weight (when loaded) of 6 tons. Captain Parsons had the models constructed at the Applied Physics Laboratory in Silver Spring, Maryland, and tested at the Naval Proving Ground on the Potomac River at Dahlgren, Virginia. The laboratory's delivery group then conducted in-flight tests in a modified B-29, dropping dummy models of both types of bombs, at the Muroc Army Air Field near San Francisco. The ballistical characteristics of Thin Man were satisfactory, but Fat Man displayed serious instability, fortunately soon overcome by a relatively simple modification in the tail assembly.[10]

But the sense of having achieved substantial progress in weapon design and fabrication was marred by a number of uncertainties. The feasibility of implosion had yet to be demonstrated and the rate at which U-235 and Pu-239 could be produced by the Clinton and Hanford plants remained very much in question. And in July,

[8] MDH, Bk. 8, Vol. 1, "General," pp. 5.12-5.13, 6.12, Apps. A8 (Site Map) and D16 (Site Constr Data), and Vol. 2, pp. VII.30-VII.31, XVI.12, XVI.14-XVI.15, XIX.1-XIX.5, DASA; Hewlett and Anderson, *New World*, pp. 312-17.

[9] Groves, *Now It Can Be Told*, pp. 288-89; MPC Min, 23 Jul 44, MDR. The bottle-shaped steel receptacle for the implosion device was designated "Jumbo" because of its massive size (25 by 12 feet) and weight (214 tons).

[10] MPC Rpt, 7 Aug 44, OCG Files, Gen Corresp, MP Files, Fldr 25, Tab K, MDR. Ltr, Parsons to Groves, 24 Dec 43; Rpt, Parsons, sub: Prgm for Flight Test of Dummy Bombs from B-29 Plane, 24 Dec 43. Both in Admin Files, Gen Corresp, 600.913, MDR. Ltr, Parsons to Norman F. Ramsey (Delivery Gp, Los Alamos Lab), 17 Jul 43, Admin Files, Gen Corresp, 600.12 (Research), MDR.

Los Alamos scientists furnished disquieting new data on the plutonium that would be produced in the Hanford piles, indicating the composition of its neutron background would cause predetonation in the plutonium gun.

Project scientists had known for some time that in the process of irradiating uranium in the pile some of the Pu-239 was likely to pick up an extra neutron, forming Pu-240. When plutonium from the Clinton pilot pile became available in the spring of 1944, the radioactivity group at Los Alamos ran a series of tests that confirmed the presence of Pu-240 and indicated it would be present in far larger amounts in plutonium from the Hanford piles. Hence, the neutron background of the active material for the bombs would be several hundred times greater than was permissible. While the Pu-240 could be separated from the Pu-239 by the electromagnetic process, construction of a plant to do so would delay production of a plutonium weapon for many months.

Oppenheimer informed Conant of the 240 problem in early July. To decide how best to deal with it, Conant took immediate steps to assemble project leaders for a conference at the Metallurgical Laboratory on the seventeenth. Besides Conant, the following were in attendance: Oppenheimer, Compton, Charles A. Thomas, in his capacity as coordinator of active material purification research, Fermi, Groves, and Nichols. After some deliberation, the group decided that the predetonation threat posed by 240 made the use of plutonium in the gun-type bomb impracticable and work on this system should be suspended immediately. With this decision, even greater urgency was placed on the development of a workable implosion weapon, in which the 240, because of the higher velocities involved, would be unlikely to cause predetonation.[11]

Abandonment of the plutonium gun compelled General Groves to revise his predictions on when an atomic weapon would be ready for employment against the enemy. In a progress report to General Marshall in early August, he presented a revised timetable of weapon production: five to eleven implosion bombs in the period from March through June 1945, with an additional twenty to forty implosion bombs of the same size by the end of the year. He cautioned, however, that this schedule would not apply "if experiments yet to be conducted with an implosion type bomb do not fulfill expectations and we are required to rely on the gun type alone" and suggested that, if this delay should occur, the first bomb would not be ready until 1 August 1945, with one or two more by the year's end. In Groves's opinion, any delay virtually guaranteed that the bomb would not be used against Germany, which by the late summer of 1944 appeared likely to be defeated within a few months. And to many, even the bomb's use against Japan seemed doubtful.[12]

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[11] Groves Diary, 17–18 Jul 44, LRG; Ltrs, Oppenheimer to Conant, 11 Jul 44, and Tolman to Groves, 21 Jul 44, OSRD; Ltr, Oppenheimer to Groves, 18 Jul 44, Admin Files, Gen Corresp, 400.17 (Mfg-Prod-Fab), MDR.

[12] Quotation from MPC Rpt, 7 Aug 44, MDR. Groves continued to hold to the idea that the Germans might soon be ready to use an atomic weapon against the Allies and, therefore, that the Americans must continue to be prepared to counter this threat

Continued

Through the remaining months of 1944 and the first half of 1945, programs to perfect the uranium gun and implosion principle absorbed the major energies and resources of the reorganized laboratory. As predicted by the Los Alamos scientists, development of the gun moved ahead smoothly with few serious problems. Experiments by the laboratory's physicists proved the correctness of earlier estimates of the critical mass of the U-235 metal required for the gun and the gun group conducted successful firing tests, using a full-sized tube and substituting U-238 for U-235.

Implosion, by way of contrast, continued to be afflicted with doubts and uncertainties. Progress toward achieving sufficient symmetry in implosion was discouragingly slow. Of the various implosion bomb designs, that proposing the use of explosive "lenses" appeared most feasible.[13] A more accurate assessment was achieved with the first tests: Results were so unpromising that in December 1944 Groves and Conant concluded that U-235 should not be used in an implosion bomb but be conserved for the certain-to-work gun.[14]

As the new year opened, surprising developments dispelled the lingering air of discouragement. In February, when Groves, Tolman, and Conant visited Los Alamos, they found far more reasons for optimism. A few days before their arrival on the twenty-seventh, the gun group finally had frozen design on the U-235 weapon, indicating a usable model would be ready by July. Implosion also had made notable progress, and laboratory leaders decided, in a conference that Groves attended, to manufacture the implosion model favored by Oppenheimer. And to ensure at least one implosion bomb test with active material by 4 July, Oppenheimer also decided to use the California Institute of Technology's Project Camel facilities for construction of a second model with alternate design features. At this juncture, with data from Hanford indicating that shipments of plutonium in quantity would begin to arrive at Los Alamos in May, with experiments on accurate establishment of the critical measurements on Pu-239 in progress at the Metallurgical Laboratory, and with construction of a much larger plant for final purification of plutonium at

with their own atomic weapon. But Hewlett and Anderson (*New World*, p. 253) note that earlier developments all pointed to Japan, not Germany, as the ultimate target for the bomb. As early as May 1943, the Military Policy Committee (see MPC Min, 5 May 43, OGG Files, Gen Corresp, MP Files, Fldr 23, Tab A, MDR) concluded that the optimum target would be the Japanese fleet anchored at Truk. Then in September of that year choice of the new B-29, scheduled for employment in the Pacific Theater, over the British Lancaster seemed to imply that the bomb was to be used against Japan. See Ch. XXVI.

[13] Tubes, shaped like optical lenses and filled with high explosives, were placed in a symmetrical pattern around the active material (Pu-239). When the explosives detonated, they created an inward blast that compressed the active material until it reacbed a critical mass.

[14] Rpt, Cmdr A. Francis Birch (Gun Gp Ldr, Los Alamos Lab), sub: Gun-assembled Nuclear Bomb, 6 Oct 45, OCG Files, Gen Corresp, MP Files, Fldr 16, Tab E; Ltr, Oppenheimer to Groves, 30 Jun 45, and Rpt, prepared by Bristish scientists at Los Alamos, 7 May 45, OCG Files, Gen Corresp, MP Files, Fldr 17; Ltrs, Oppenheimer to Groves, 6 Oct and 14 Nov 44, Admin Files, Gen Corresp, 600.12 (Research); Ltr, Oppenheimer to Groves, 8 Dec 44, OCG Files, Gen Corresp, MP Files, Fldr 19, Tab D. All in MDR. Rpt, Conant, sub: Summary of Trip to Y, Dec 44, OSRD. Groves Diary, 19 Dec 44, LRG. Hewlett and Anderson, *New World*, pp. 317-21.

Los Alamos well under way, the Trinity test date now appeared feasible.[15]

Project Trinity: The Test of the Bomb

Project Trinity was the final step of the Los Alamos weapon program, the culmination of the laboratory's reorientation from research and experimentation to engineering, fabrication, and testing of an atomic device. Without Trinity, without the test of the bomb, the feasibility of employing the new weapon appeared to be much more questionable. "If we do not have accurate test data from Trinity," Oppenheimer and Kistiakowsky had warned, "the planning of the use of the gadget over the enemy territory will have to be done substantially blindly." As 1945 unfolded, the Trinity mission became the central focus for the scientists at Los Alamos. With the bomb test now first priority, the tempo and intensity of Trinity preparations increased dramatically.[16]

In the critical months of early 1945, making the gadget work consumed the energies of both the bomb builders and Army leaders. While the scientists worked at perfecting implosion assembly and field teams prepared the remote Trinity test site at Alamogordo, General Groves and his new deputy commander, Brig. Gen. Thomas F. Farrell, devoted much time to overseeing Trinity preparations. Because of pressures of other responsibilities, including planning for use of the bomb against Japan and for the postwar control of atomic energy, Groves managed only three hurried visits to Los Alamos during the months of full-scale preparations (April to July), but he was able to maintain day-to-day contact with bomb test developments through timely observation reports from Farrell, who made several extended tours to the Trinity site.

As Trinity preparations began, Groves had advised Colonel Tyler, the Los Alamos post commander, that he must carefully coordinate plans for development of the bomb test with the laboratory staff and with Farrell "so that every part of it fits into a time schedule." As procurement crises built up in April and May, Groves personally intervened in expediting requisition of lenses for the implosion bomb and globe-shaped container shells ("pumpkins") for imploding test devices. In May, with a special report by Farrell on means to improve the procurement situation at the New Mexico installation to guide him, the Manhattan commander con-

[15] Rpt, Birch, sub: Gun-assembled Nuclear Bomb, 6 Oct 45, MDR; Memo, Groves to Secy War, sub: Atomic Fission Bombs, 23 Apr 45, OCG Files, MP Files, Fldr 25, Tab M, MDR; Groves Diary, 27 Feb–2 Mar 45, LRG. On the continuing program to establish more exact measurements concerning plutonium see Memos, Groves to Nichols, sub: Measurements Prgm, 3 Apr 45, and Nichols to Groves, 10 Apr 45, same sub, Admin Files, Gen Corresp, 400.12 (Experiments), MDR. On the expansion of plutonium fabrication facilities at Los Alamos see MDH, Bk. 8, Vol. 2, XVII.20–XVII.22, DASA, and Ltr, Roger Williams (TNX Div chief, Du Pont) to Groves, 16 May 45, Admin Files, Gen Corresp, 337, MDR. For the views of the British scientists at Los Alamos on the progress of bomb development in early 1945 see Admin Files, Gen Corresp, 201 (Chadwick), MDR.

[16] Quotation from Rpt, Oppenheimer and Kistiakowsky, sub: Activities at Trinity, 13 Oct 44, Admin Files, Gen Corresp, 600.12 (Los Alamos), MDR. Except as otherwise indicated, the section that follows on the Trinity test is based on MDH, Bk. 8, Vol. 2, pp. XVIII.1–XVIII.22, DASA, and Hewlett and Anderson, *New World*, pp. 376–80. For a popular account see Lamont, *Day of Trinity*, pp. 2–13 and 72–236.

BRIG. GEN. THOMAS A. FARRELL *(right) with General Groves*

tributed to the agreement with the University of California to hire more procurement personnel. Finally, in the weeks immediately preceding the test, Groves and Farrell devoted special attention to shipment and receipt of active materials from Hanford and Clinton.[17]

General Farrell represented the Army at Trinity's first major event on 7 May—a rehearsal shot of 100 tons of high explosives combined with a very small amount of radioactive fission materials atop a 20-foot platform. Observers, including Tolman and Oppenheimer, judged it a successful trial run for the final implosion test. It gave the various Project Trinity teams practical experience in performing their assignments under difficult field conditions, demonstrated a need for improvements in the transportation and communications facilities, helped calibrate instruments, and provided a likely indication of the amount of radioactive materials needed for the final test.[18]

In early June, "Jumbo," the huge steel container to be used in exploding the first atomic device, arrived at Trinity. General Groves had maintained a special interest in the design, procurement, and shipment of the vessel, which was moved in early April on a special railroad car from Barberton, Ohio, via a carefully planned route to a railroad siding at Pope, New Mexico. There, Trinity workers loaded it on a massive trailer pulled by two tractors for the 25-mile trip to the test site. When the vessel finally came to rest some 800 yards from the final test tower, there it remained never to be used. For by the time of Jumbo's arrival, Los Alamos scientists had decided to dispense with the container, concluding that its use would interfere with obtaining adequate data on the nature of the atomic explosion—the primary reason for conducting the Trinity test.[19]

[17] In January 1945, after the Secretary of War had advised the Manhattan commander that he should select an officer who could replace him in the event of his illness or death, Groves chose Farrell, a Corps of Engineers officer who, in 1941, had served as his deputy in the military construction program before going overseas to the China-Burma-India Theater. See Groves, *Now It Can Be Told*, pp. 30–32; Groves Diary, 9 Jan, 1 Feb, 23 Mar, 29 Mar (source of quotation), Apr–Jun 45, passim, LRG; Memo for File, Groves, sub: Note Taken at Mtg at Y, 27 Jun 45, OCG Files, Gen Corresp, MP Files, Fldr 20, Tab F, MDR.

[18] Rpt, sub: Trinity, 14 May 45, Admin Files, Gen Corresp, 319.1 (Trinity Test Rpts–Misc), MDR; Memo, Col Stafford L. Warren (MD Med Sec chief) to Groves, sub: Analysis of Problems Presented by Test II at Muriel (Trinity), 16 May 45, OCG Files, Gen Corresp, MP Files, Fldr 4, Tab H, MDR; Groves Diary, 7 May 45, LRG.

[19] Trinity scientists, too, were much more confident of the success of implosion and certain that,

Continued

Although 4 July had been set as the target date for the test, few scientists at Los Alamos were convinced it could be met. Precise scheduling depended upon bringing a tremendous number of factors into proper juxtaposition, including weather, procurement of key components and equipment, production and shipment of active material, preparation of many experiments, and arrangement of security and safety measures. In mid-June, Oppenheimer announced to the laboratory's group leaders that 13 July was the earliest possible date, with up to ten days later not unreasonable. He based his estimate upon information provided by the laboratory's cowpuncher committee, which had primary responsibility for coordination and scheduling of Trinity.

Following another review of developments on 30 June, this committee advanced the test date to 16 July to permit inclusion of certain additional vital experiments. Two days later, Oppenheimer indicated to Groves that the laboratory leaders finally had agreed on the seventeenth. Groves, however, objected to the later date, pointing out that the situation in Washington required an earlier date. With the end of the war in Europe, Secretary Stimson was scheduled to depart in early July for the Potsdam Conference, with sessions starting on the sixteenth. The Manhattan commander undoubtedly had conferred with Conant, Tolman, and Stimson's assistants, George L. Harrison and Harvey Bundy, all of whom favored carrying out the test on the fourteenth. Again Oppenheimer consulted with the bomb test team, which reported continued difficulties with the implosion device, wiring at Trinity, and uncertainty concerning receipt of active material. On that basis he informed Groves on 3 July that the test date of the seventeenth must stand. But final preparations advanced more rapidly than expected, and Oppenheimer called Groves on the seventh to announce that the test might take place after all on the sixteenth.[20]

In the final days before the test, the Army had the major responsibility for completing security and safety arrangements. To meet the eventuality that the people living in towns and on ranches in the immediate vicinity might have to be evacuated to avoid radioactive fallout, the Army stationed a detachment of 160 enlisted men with vehicles at Socorro (New Mexico) and other strategic points along main highways a few miles north of the site. (*See Map 6.*) To supplement this detachment and also to increase security, the Army detailed about 25 CIC (Counterintelligence Corps) members to towns and cities up to 100 miles from the Trinity site, with instructions to summon evacua-

with the rapidly increasing production at the Hanford and Clinton Works, more active material would be available. For further details on Jumbo see MDH, Bk. 8, Vol. 2, p. XVIII.6, DASA; Groves Diary, 30 Mar 45, LRG; Memos, Groves to Alburquerque Dist Engr, sub: Trans Contract, Trinity Proj, 7 Feb 45, Capt Philip Firmin (Wash Liaison Office) to Groves, sub: Status of Jumbo and Special Trailer, 30 Mar 45, and Farrell to Groves, sub: Jumbo, 4 Jun 45, Admin Files, Gen Corresp, 400 (Equipment-Trinity), MDR; Groves, *Now It Can Be Told*, pp. 288–89.

[20] Memo, Oppenheimer to All Gp Ldrs (Los Alamos), sub: Trinity Test, 14 Jun 45, File No. 314.7 (Trinity), LASL; Ltr, Tolman to Groves, sub: Prgm for Trinity Test, 17 Apr 45, Admin Files, Gen Corresp, 400 (Equipment-Trinity), MDR; Ltr, Oppenheimer to Groves, 27 Jun 45, OSRD; Groves Diary, 2–4 and 7 Jul 45, LRG; Stimson Diary, 6 Jul 45, HLS.

tion troops if they were needed and to help circulate the Manhattan Project's cover story about an ammunition dump explosion. An officer from Groves's headquarters had already taken this story to the commander of the Alamogordo base, to be issued as soon as the test took place. Another project officer took up a station in the Associated Press office in Albuquerque to suppress any stories that might alarm the public unduly. Earlier, Groves had arranged with the Office of Censorship in Washington, D.C., to keep news of the explosion from getting into newspapers in other parts of the country. Finally, the Alamogordo commander had reluctantly acceded to the Army's request to suspend all flights during the test.[21]

Meanwhile, scientists and technicians at the Trinity site were completing preparations. On 12 July, two scientists from Los Alamos arrived in an Army sedan with the Pu-239 core for the implosion device. The next day a convoy came from the Hill with the nonnuclear components, including the high explosives. Before the test device assembly team moved the plutonium core to the tent at the base of the 100-foot steel shot tower, General Farrell signed a receipt for the active material, thus formally completing transfer of the Pu-239 from the scientists to the Army for use in the test. With all components in place except the detonating system, workers removed the tent and a hoist lifted the device to a metal shed on a platform at the top of the tower. The detonator group then completed the firing circuit and other technicians added apparatus for experiments. By five in the afternoon of the fourteenth, the device was ready for the test.[22]

The next day, a Sunday, Trinity crews carried out last-minute inspections and observers checked into the base camp, about 10 miles south of the test tower. OSRD Director Vannevar Bush and Conant arrived from Pasadena with General Groves; Army sedans brought Charles Thomas from Santa Fe and Ernest Lawrence, Sir James Chadwick, and *New York Times* science reporter William L. Laurence, as well as others, from Albuquerque. Compton had decided not to come. Tolman and General Farrell were already on hand. The large contingent from Los Alamos, aboard three buses, did not reach Trinity until shortly before three in the morning of 16 July, barely in time for the originally scheduled zero hour, 4:00 A.M. They stepped out into blustery and rainy weather with occasional flashes of lightning—not the clear skies and moderate winds the Trinity meteorologists had predicted.[23]

[21] Groves, *Now It Can Be Told,* pp. 299–301; Memo, 14 May 45, OCG Files, Gen Corresp, MP Files, Fldr 4, Tab A; Notes on Interim Committee Mtg, 18 May 45, OCG Files, Gen Corresp, Groves Files, Fldr 3, Tab O. See also materials and reports in Admin Files, Gen Corresp, 319.1 (Trinity Test Rpts-Misc). All in MDR.

[22] MDH, Bk. 8, Vol. 2, pp. XVIII.12-XVIII.14, DASA; Hewlett and Anderson, *New World,* p. 378; Product Receipt No. 5502, signed by Farrell and approved by Groves, 13 Jul 45, OCG Files, Gen Corresp, MP Files, Fldr 25, Tab I, MDR. This is the receipt registering the transfer of Pu-239 from the Los Alamos Laboratory to the Army. In a note appended by Farrell on 16 July, he states that he "witnessed the expenditure of the above materials in the first nuclear explosion thus marking the birth of the age of atomics."

[23] Groves Diary, 11–14 Jul 45, LRG; Groves, *Now It Can Be Told,* pp. 290–91.

TRINITY CONTROL DUGOUT AND OBSERVATION POST, *located six miles from the detonation point*

Oppenheimer and Groves had reviewed the weather situation at midnight and then had gone forward from the base camp some 7,000 yards to the control dugout (10,000 yards from the test tower) to wait with Farrell, physicist Kenneth Bainbridge, who was the leader of the bomb test team, and chief meteorologist Jack M. Hubbard, who with Oppenheimer had responsibility for making the final decision on whether to carry out the test as scheduled. As four o'clock approached and the rain continued, Groves and Oppenheimer weighed the risks of going ahead—the likelihood of heavier radioactive fallout at some points, electrical failures from dampened circuits, and poor visibility for the observation airplanes. They decided to delay the shot an hour and a half. The rain stopped at four and shortly before five, with wind still blowing in the right direction, they gave the go-ahead signal for the test.[24]

As the final countdown began, Groves left Oppenheimer and Farrell in the control dugout and returned to the base camp, a better point of observation and in compliance with the Manhattan chief's rule that he and Farrell must not be together in situations where there was an element of danger. At approximately the same time, the five Trinity scientists who had been guarding the test device drove away in their jeeps as bright

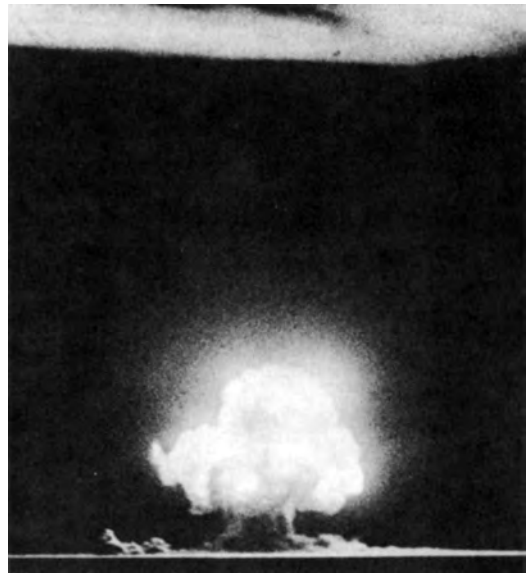
[24] Memo, Groves to Secy War, sub: The Test, 18 Jul 45, HB Files, Fldr 49, MDR; Groves, *Now It Can Be Told*, pp. 291–95 and 433–40 (App. 8, which is a

Continued

lights illuminated the tower to foil any would-be saboteurs. Precisely at 5:30 A.M., an automatic firing mechanism actuated the implosion device.

Data from hundreds of instruments recorded what occurred in that desolate stretch of the Jornada del Muerto valley: the dawn of the atomic age. It began with a brilliant yellow light that suffused the remotest recesses of the Trinity site and was seen as far away as Albuquerque and Los Alamos to the north, Silver City (New Mexico) to the west, and El Paso (Texas) to the south. With the light came a sensation of heat that persisted even as a huge ball of fire—like a rising sun—took shape, then transformed quickly into a moving orange and red column. Out of this broad spectrum of colors rose a narrower column that rapidly spilled over to form a giant white mushroom cloud surrounded by a blue glow. Only as the glow began to fade did observers at the base camp feel the pressure of the shock wave, but its rumble reverberated for more than five minutes in the surrounding hills.[25]

The effects of this explosion on eyewitnesses were as varied as the observers themselves. What General Farrell, for example, saw and heard from the control dugout was "unprecedented, magnificent, beautiful, stupendous and terrifying. . . . The whole country was lighted by a searing light with the intensity many times that of the midday sun. It was golden, purple, violet, gray and blue. It lighted every peak, crevasse and ridge of the nearby mountain range with a beauty . . . the great poets dream about. . . . Thirty seconds after, the explosion came . . . followed almost immediately by the strong, sustained, awesome roar which warned of doomsday. . . ." What General Groves recalled was that "Drs. Conant and Bush and myself were struck by an even stronger feeling that the faith of those who had been responsible for the initiation and the carrying-on of the Herculean project had been justified. I personally thought of Blondin crossing Niagara Falls on his tightrope, only to me this tightrope had lasted almost three years, and of my repeated, confident-appearing assurances that such a



THE ATOMIC EXPLOSION AT TRINITY, 16 JULY 1945

reprint of the 18 Jul 45 memorandum with some editorial changes and without inclosures); MDH, Bk. 8, Vol. 2, pp. XVIII.14-XVIII.15, DASA; Memo, Warren to Groves, sub: Safeguards for Test II at Muriel (Trinity), 27 Jun 45, OCG Files, Gen Corresp, MP Files, Fldr 4, Tab H, MDR.

[25] Hewlett and Anderson, *New World*, p. 379. See also the eyewitness and other reports on the Trinity test in Admin Files, Gen Corresp, 319.1 (Trinity Test Rpts–Misc), MDR.

thing was possible and that we would do it." [26]

But the Manhattan commander permitted himself only a fleeting moment of relaxation. Less than half an hour after the test shot he called his secretary in Washington, D.C., to inform George Harrison so that he could pass on word of the test to Stimson in Potsdam. Groves's two main concerns were the explosive strength of the implosion device and the impact of the test on project security. There were strong indications, Groves reported, that the strength of the explosion was at least "satisfactory plus" and perhaps far greater than estimated. As to the effects of the test on project security, he would take the necessary measures as soon as its impact on the public had become apparent. By late morning there was evidence that the explosion had aroused considerable excitement throughout New Mexico and in west Texas, near El Paso. Groves gave permission to the Associated Press at Albuquerque to release the previously prepared cover story with such changes as were necessary to fit the exact circumstances of the test:

Alamogordo, N.M., July 16

The commanding officer of the Alamogordo Army Air Base made the following statement today:

Several inquiries have been received concerning a heavy explosion which occurred on the Alamogordo Air Base reservation this morning.

A remotely located ammunition magazine containing a considerable amount of high explosives and pyrotechnics exploded.

There was no loss of life or injury to anyone, and the property damage outside of the explosive magazine itself was negligible.

Weather conditions affecting the content of gas shells exploded by the blast may make it desirable for the Army to evacuate temporarily a few civilians from their homes.[27]

That same afternoon, news of the momentous event reached Secretary Stimson in Potsdam:

Operated on this morning. Diagnosis not yet complete but results seem satisfactory and already exceed expectations. Local press release necessary as interest extends great distance. Dr. Groves pleased. He returns tomorrow. I will keep you posted.[28]

A follow-up cable from Harrison confirmed the success, tentatively implied in the first message:

Doctor has just returned most enthusiastic and confident that the little boy is as husky as his big brother. The light in his eyes discernible from here to High Hold and I could have heard his screams from here to my farm.[29]

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[26] In his 18 Jul 45 memorandum (source of quotations) for the Secretary of War in Potsdam describing the Trinity test in detail, Groves incorporated Farrell's description of the explosion. He also attached as an inclosure Ernest Lawrence's "thoughts" on the Alamogordo test. See HB Files, Fldr 49, MDR. The memorandum and inclosure are also reproduced in U.S. Department of State, *The Conference of Berlin (The Potsdam Conference), 1945*, Foreign Relations of the United States, Diplomatic Papers, 1945, 2 vols. (Washington, D.C.: Government Printing Office, 1960), 2:1361-70.

[27] The cover story released was one of several possible versions prepared in May by personnel in Groves's office. See Memo, 14 May 45, MDR. The story is also reprinted in Groves, *Now It Can Be Told*, p. 301. A transcription of Groves's telephone call to his secretary (Mrs. Jean O'Leary) on 16 Jul 45 is in Admin Files, Gen Corresp, 319.1 (Trinity Test Rpt), MDR.

[28] Msg, Harrison to Stimson, 16 Jul 45, CM-OUT-32887, OCG Files, Gen Corresp, MP Files, Fldr 5E, Tab A. Copy also in HB Files, Fldr 64. Both in MDR.

[29] Msg, Harrison to Stimson, 17 Jul 45, CM-OUT-33556, OCG Files, Gen Corresp, MP Files, Fldr 5E, Tab A. Copy also in HB Files, Fldr 64. Both in MDR.

Stimson passed on this second cable to Truman at once, explaining to the President that Groves ("Doctor") was convinced that the implosion bomb ("little boy") was as powerful as the gun-type bomb ("big brother"). Proof of its power was the fact that the light of the explosion was visible for 250 miles (the distance from Washington to Stimson's summer home at High Hold on Long Island) and its sound was audible for 50 miles (the distance from Washington to Harrison's farm near Upperville, Virginia). Stimson, Truman, Churchill, and other Allied leaders at Potsdam were quick to realize that this preliminary evidence of the enormous power of the Trinity explosion, followed soon by more detailed substantiating data from General Groves, had introduced a new factor that would profoundly affect not only their own deliberations on how to end the war with Japan but also the whole course of international relations in the postwar world.[30]

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[30] On the limited effect of the Trinity test on project security see Notes, 1st Lt Thomas R. Mountain to Mrs. O'Leary, 17 Jul 45, Admin Files, Gen Corresp, 371.2 (Scty), MDR; Stimson Diary, 16–18 Jul 45, HLS. Subsequent detailed conclusions on the effectiveness of the implosion device are given in Memo, Groves to Chief of Staff, 30 Jul 45, OCG Files, Gen Corresp, MP Files, Fldr 4, Tab C, MDR.

CHAPTER XXVI

The Atomic Bombing of Japan

The explosion of an implosion device on 16 July 1945 at Trinity provided final confirmation to America's wartime leaders that employment of an atomic weapon in the war with Japan was indeed a strategic reality. Until 1945, the Army's supersecret atomic weapon program had not been a factor in strategic planning for carrying on the war, either in Europe or in the Pacific.[1] The successful Allied operations against Germany in the summer of 1944 portended that country's imminent collapse and obviated the need for an atomic weapon to end the conflict in Europe. Because of these developments, Manhattan Project leaders thus considered using the bomb in the war in the Pacific and accelerated preliminary planning with the Army Air Forces (AAF) for a possible atomic bombing mission against Japan.

[1] Strategic planning for employment of the atomic bomb always was limited to the relatively few military and civilian leaders who knew of its existence. Most Army planners remained totally unaware of the atomic weapon program. In the Operations Division only three senior officers—General Malin Craig, Lt. Gen. John E. Hull, and Brig. Gen. George A. Lincoln—learned about the bomb before it was dropped on Japan. See Ray S. Cline, *Washington Command Post: The Operations Division*, U.S. Army in World War II (Washington, D.C.: Government Printing Office, 1951), p. 347.

Preparations for an Atomic Bombing Mission

Preparations for the tactical employment of an atomic weapon against Japan began in late March 1944, when General Groves first met with General Henry H. Arnold, the AAF commanding general.[2] The Manhattan commander briefed Arnold, who already had some knowledge of the atomic program, on the current status of bomb development, estimating the probable time when bombs would be ready for use in combat. He then reviewed the latest technical data from Los Alamos on

[2] Except as otherwise indicated, this account of the long-range preparations for employment of the atomic bomb in combat is based on Ms, "History of the 509th Composite Group, 17 December 1944 to 15 August 1945," 31 Aug 45, SHRC; Cert of Audit MDE 228-46, W-47 Spec Ord Det, 27 Sep 45, Fiscal and Audit Files, Certs of Audit (Sup), MDR; Historical Notes on Svc of Col Elmer E. Kirkpatrick, Jr., With Manhattan Proj, 1944-47, Incl to Ltr, Kirkpatrick to OCEHD, 30 Sep 68, OCEHD; MDH, Bk. 8, Vol. 2, "Technical," pp. XIX.1-XIX.13, DASA; Wesley Frank Craven and Janes Lea Cate, eds., *The Pacific: Matterhorn to Nagasaki, June 1944 to August 1945*, The Army Air Forces in World War II, Vol. 5 (Chicago: University of Chicago Press, 1953), pp. 704-09; Groves, *Now It Can Be Told*, pp. 253-62 and 277-87; Hewlett and Anderson, *New World*, pp. 252-54, 313, 317-18, 321, 334; William L. Laurence, *Dawn Over Zero: The Story of the Atomic Bomb*, 2d ed. enl. (Westport, Conn.: Greenwood Press, 1977), pp. 196-206.

the likely size, weight, and configuration of an atomic bomb, indicating that the dimensions of the gun type were reasonably well established but those for the implosion type were still very much in question.

The two leaders next took up the question of what type of airplane would be required to transport atomic bombs. The Manhattan commander noted that Oppenheimer, on the basis of investigations carried out at Los Alamos and Muroc Army Air Field, had concluded that a modified B-29 probably had the requisite weight-carrying capacity and range. Should the B-29, which had gone into production in September 1943, prove not feasible, Groves suggested the British Lancaster would have to be considered. This displeased Arnold, who stated emphatically that an American-made airplane should carry the bombs, and he promised to make a special effort to have a B-29 available for that purpose.[3]

With this assurance that the AAF would provide the necessary airplanes, the two leaders reached tentative agreement on a broad division of responsibilities in making the preparations for that atomic bombing mission. The AAF would organize and train the requisite tactical bomb unit, which, for reasons of security, must be as self-sustaining as possible and exercise full control over delivery of bombs on the targets selected. Manhattan would receive from the AAF whatever assistance it needed in ballistic testing of bombs and air transportation of materials and equipment. To facilitate close coordination between the two organizations, Groves would continue to have as frequent access to Arnold as he deemed necessary, and Maj. John A. Derry of Groves's staff and Maj. Gen. Oliver P. Echols, an AAF officer already serving as a consultant with Manhattan, would provide day-to-day liaison. Echols subsequently designated an alternate, Col. Roscoe C. Wilson, who since the latter part of 1943 had been providing AAF liaison with the Los Alamos delivery group in its work on B-29 modification and testing.[4]

In the ensuing months, General Groves personally assisted the AAF in developing an overall and concrete tactical plan. As soon as the anticipated schedule of fission bomb production was available, Groves supplied Colonel Wilson with the crucial data. Drawing upon estimates he had recently prepared for the Military Policy Committee's August progress report to the Secretary of War, Chief of Staff, and Vice President, the Manhattan commander indicated to Wilson that an implosion-type bomb might be ready as early as January 1945 and a gun-type bomb by June of that year. Although these dates were slightly in advance of those in the progress report, they illustrate a precautionary maneuver on Groves's part "to avoid any possible unnecessary delay in the use of the bomb. . . ." [5] Pending

[3] Groves Diary, 21 Mar 44, LRG; H. H. Arnold, *Global Mission* (New York: Harper and Brothers, 1949), p. 491.

[4] On the earlier liaison arrangements with the AAF see MPC Min, 9 Nov 43, OCG Files, Gen Corresp, MP Files, Fldr 23, Tab A, MDR; MDH, Bk. 8, Vol. 2, pp. VII.35-VII.39, DASA. The frequent consultations between Manhattan and AAF personnel during the fall and winter of 1944 are recorded in Groves Diary, Sep-Dec 44, passim, LRG.

[5] Groves, *Now It Can Be Told*, p. 256, n. 2.

completion of the fission bombs, Groves assured Wilson that, for testing purposes, Manhattan would supply the AAF with several hundred high-explosive bombs having ballistic characteristics similar to the implosion-type model.[6]

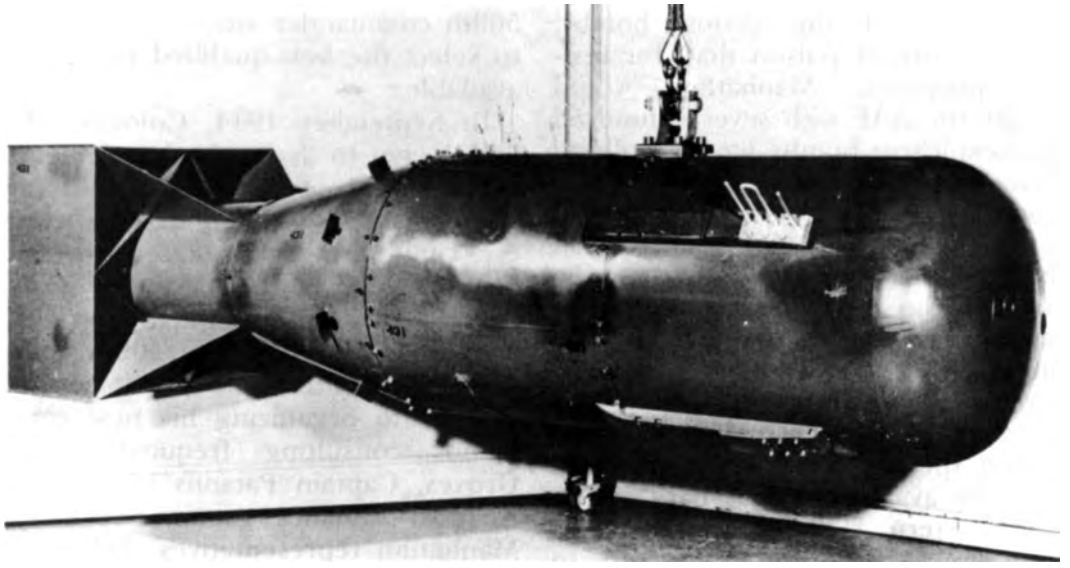
On the basis of this data, Wilson drafted a general plan outlining the support the AAF would provide in preparation for the atomic bombing mission. The AAF committed itself to supply the personnel and equipment for a heavy bomb squadron, with attached special units as required, and to make available an air base in the southwestern United States for its training. In addition, it agreed to modify and complete delivery of fourteen B–29's to the squadron by 1 January 1945; to continue flight testing of implosion-type bombs, with related training under direction of Manhattan and AAF specialists; and to assist Manhattan personnel in testing equipment and assembling ballistic data. Finally, the AAF would participate in a field inspection of a suitable site for an overseas operating base on the Mariana Islands in the Central Pacific.

To command the bomb combat unit, subsequently designated the 509th Composite Group and formally activated on 17 December 1944, General Arnold selected Col. Paul W. Tibbets, Jr. Tibbets had an outstanding record in flying heavy bombers in Europe and North Africa and had gained a special knowledge of the B–29 as a test pilot. Because of the great importance and secrecy of the 509th's mission, Arnold gave the 509th commander virtual *carte blanche* to select the best-qualified personnel available.

In September 1944, Colonel Tibbets began to assemble the elements of the 509th at Wendover Field (*see Map 2*), an isolated air base in western Utah with adequate security and facilities and well located for air travel to Los Alamos and the Salton Sea Naval Air Station.[7] The 509th commander devoted the next several months to organizing his new command, consulting frequently with Groves, Captain Parsons of the Los Alamos ordnance group, and other Manhattan representatives. Following the security guidelines set forth in Colonel Wilson's plan, Tibbets formed the various elements of the 509th with the objective of making it as self-sufficient as possible. Thus, he included in the group not only a normal B–29 unit, the 393d Bombardment Squadron (VH), but also a number of supporting elements, including the 390th Air Service Group (consisting of the 603d Air Engineering and 1027th Materiel Squadrons), the 320th Troop Carrier Squadron, and the 1395th Military Police Company (Aviation). Subsequently, for special technical requirements, the 509th acquired the 1st Ordnance Squadron, Special (Aviation), and the 1st Technical Detachment, War Department Miscellaneous Group, a catchall unit comprised of both civilian and military scientists and techni-

[6] See MPC Rpt, 7 Aug 44, Incl to Memo, Groves (for MPC) to Chief of Staff, same date, OCG Files, MP Files, Fldr 25, Tab K, MDR; Groves Diary, 31 Jul and 17, 21, 29 Aug 44, LRG.

[7] Los Alamos personnel, given the task of constructing bombing tables, acquired the necessary data from field measurements taken at the Salton Sea Naval Air Station, where an approach over water simulated the near sea-level conditions that would be encountered over Japan.



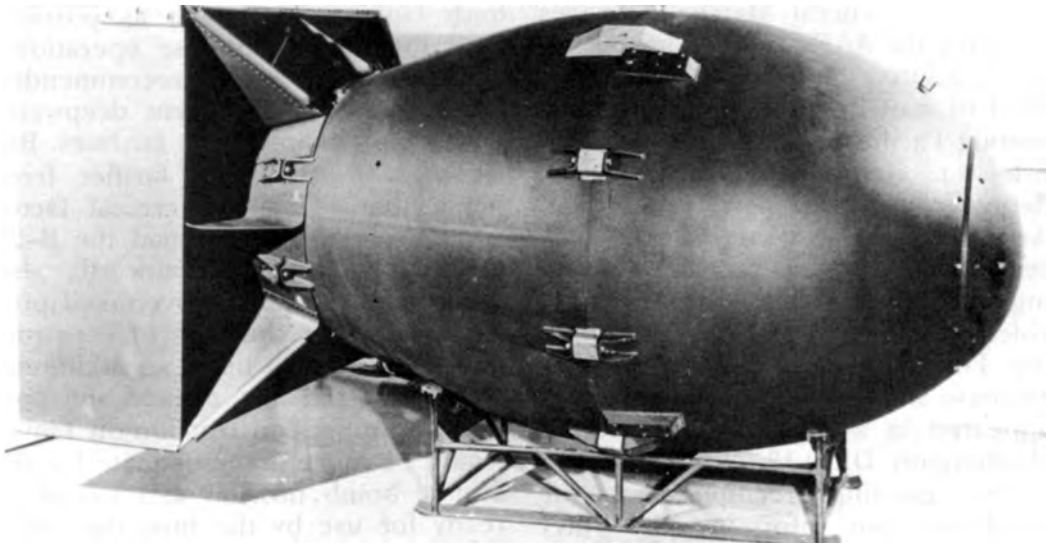
LITTLE BOY, *the uranium bomb dropped on Hiroshima*

cians—many from the Manhattan Project but including Army, Navy, and AAF personnel.[8]

At the beginning of September, with the external shape and aircraft requirements of the three basic bomb models—one of the U-235 gun type (now designated Little Boy instead of Thin Man) and two of the Pu-239 implosion type (Fat Man)—now frozen, the AAF started training the bomb drop squadron and, with assistance from Los Alamos technicians, completed necessary modifications on the B-29. While awaiting delivery of the first planes, scheduled under Colonel Wilson's plan to be on the thirtieth of the month, the squadron underwent training that emphasized ground and air techniques for handling atomic bombs.

In October, only days past the scheduled delivery date, the 393d received the first modified B-29's out of a production lot of fifteen (one more than originally requested). Without delay, a continuing series of essential test drops commenced at Wendover. Over the next few months, these tests furnished critical information on ballistics, electrical fusing, flight performance of electrical detonators, operation of aircraft release mechanisms, vibration, and temperatures, as well as provided bomb assembly experience. But, perhaps more importantly, they revealed certain weaknesses in the original modifications and defective performance in the flying capabilities of the big bombers.

[8] For further details on organization and composition of the 509th see Ms, "Hist 509th Comp Gp," pp. 1-2 and 8-11, SHRC, and the unit's own postwar publication, *509th Pictorial Album: Written and Published by and for the Members of the 509th Composite Group, Tinian, 1945*, ed. Capt Jerome J. Ossip (Chicago: Rogers Printing Co., 1946). By the summer of 1945, the 509th had substantially exceeded the authorized personnel of 225 officers and 1,542 men.



FAT MAN, *the implosion bomb dropped on Nagasaki*

Because B-29's were in very short supply, the AAF's lower echelons displayed some reluctance to satisfy the Manhattan request for replacement of the inadequate planes. In December, shortly after the 393d Squadron was detailed to Batista Field, Cuba, for two months of special navigational training, Groves decided to appeal directly to General Arnold about the B-29 problem. Without hesitation, the AAF chief responded emphatically that the 509th Composite Group would get as many new planes as it required. "In view of the vast national effort that had gone into the Manhattan Project," as Groves later recalled Arnold's words, "no slip-up on the part of the Air Force was going to be responsible for a failure." [9] After the 393d returned to Wendover, the fliers continued to gain experience during tests with dummy bombs of various types. Finally, in the spring of 1945, the second lot of fifteen greatly improved versions of the B-29 reached the air base, and training and ballistic tests proceeded at a more intensive pace.

The Overseas Operating Base

With training of the 509th Composite Group and the Los Alamos program for testing bomb models well under way, project leaders turned their attention to establishing a base of operations for the 509th in the Pacific Theater. At the end of December 1944, Manhattan and AAF officials, including Groves and Arnold, met to discuss plans for moving the 509th overseas. The AAF recommended that leaders of the Twentieth Air Force in the Marianas—at the time the only feasible location for the 509th base—be informed of the atomic bomb mission. With permis-

[9] Groves, *Now It Can Be Told*, p. 257.

sion from General Marshall, Groves accepted the AAF's offer to have Brig. Gen. Lauris Norstad, its assistant chief of staff for plans who would be visiting Pacific bases in January 1945, brief Lt. Gen. Millard F. Harmon, deputy commander of the Twentieth Air Force, and two of his staff officers. (Groves had to repeat the briefing again for Lt. Gen. Barney McK. Giles, who in May became Twentieth Air Force deputy commander after Harmon and the two staff officers disappeared in a flight from Guam to Washington, D.C.).[10]

The meeting reemphasized the need for also informing the Navy commanders in the Pacific of the atomic bomb mission, as Navy support in the immediate area of operations would be indispensable. Furthermore, Admiral Chester W. Nimitz, Commander in Chief, Pacific Ocean Areas (CINCPOA), had learned of the imminent arrival of the 509th in his theater and was asking questions concerning its mission. In February, Groves arranged with Rear Adm. William R. Purnell of the Military Policy Committee to have Comdr. Frederick L. Ashworth, Parsons' operations officer and military alternate in charge of field operations at Wendover, visit Nimitz's headquarters on Guam. Ashworth briefed Nimitz, who in turn informed two staff members of the 509th mission.[11]

Groves also had instructed Commander Ashworth to inspect carefully both Guam and Tinian as possible sites for the 509th base operations. General Norstad had recommended Guam, citing its excellent deepwater harbor and maintenance facilities. But Guam was 125 miles farther from Japan than Tinian—a critical factor considering the heavy load the B-29 would be carrying. Ashworth also found that Guam had overtaxed port facilities and a shortage of construction personnel to build an additional airfield. In contrast, airfield and port facilities under construction on Tinian would be more than adequate for the atomic bomb mission and would be ready for use by the time the 509th arrived in June. Furthermore, although the Army had jurisdiction over Tinian, the Navy's 6th Naval Construction Brigade was available there to build the special installations that would be needed by the mission.[12]

With the information he had collected on Guam and Tinian, Commander Ashworth reported to Groves on 22 February. The following day Groves wrote to Norstad, indicating his choice of Tinian as the more suitable site (*Map 7*). Norstad concurred, and on 24 February Groves briefed the Military Policy Committee. By end of the month, Navy Seabees were at work on the base facilities.[13]

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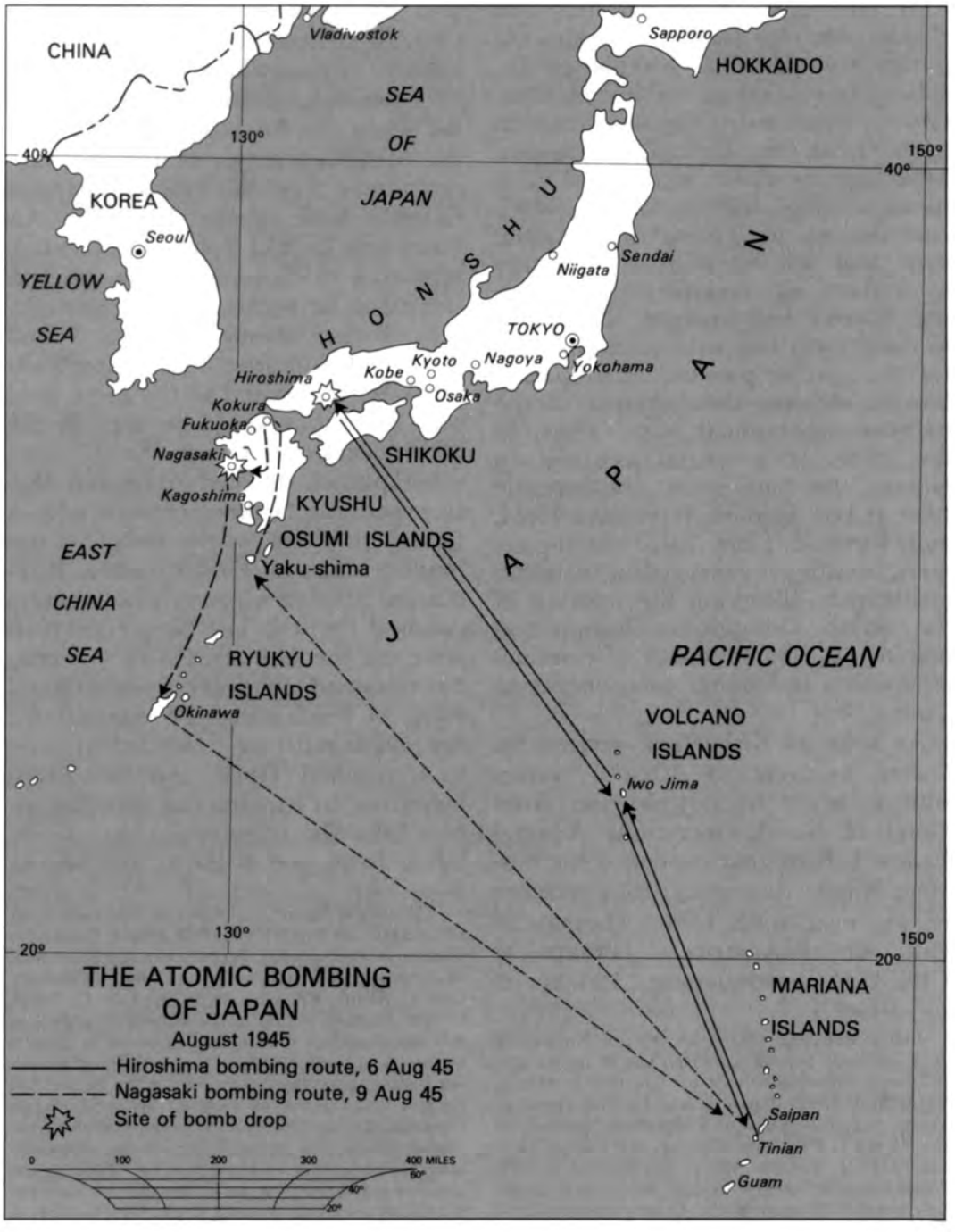
[10] MPC Min, 29 Dec 44, Exhibit H (prepared by Groves), MDR; Groves, *Now It Can Be Told*, pp. 278–79; Craven and Cate, *The Pacific*, pp. 530–31.

[11] Ltr, Groves to Chief of Staff, 30 Dec 44, OCG Files, Gen Corresp, MP Files, Fldr 23, Tab A, MDR; Groves, *Now It Can Be Told*, p. 277.

[12] Memo, Ashworth to Groves, sub: Base of Opns of 509th Comp Gp, 24 Feb 45, OCG Files, Gen Corresp, MP Files, Fldr 23, Tab A, MDR; Craven and Cate, *The Pacific*, pp. 516–17 and 518–19.

[13] Groves Diary, 22–24 Feb 45, LRG; MPC Min, 24 Feb 45, with Ashworth's 24 February memorandum attached as Exhibit A, MDR; Memo, Groves to Norstad, sub: Decisions Concerning Movement of 509th Comp Gp, 23 Feb 45, OCG Files, Gen Corresp, MP Files, Fldr 5, Tab C, MDR; Craven and Cate, *The Pacific*, p. 706; Groves, *Now It Can Be Told*, p. 278.


CHINA
Vladivostok
Sapporo
HOKKAIDO
SEA
OF
JAPAN
130°
150°
40°
KOREA
Seoul
HONSHU
Niigata
Sendai
YELLOW
SEA
TOKYO
Hiroshima
Kyoto
Nagoya
Yokohama
Kobe
Osaka
Kokura
Fukuoka
Nagasaki
SHIKOKU
Kagoshima
KYUSHU
OSUMI ISLANDS
Yaku-shima
EAST
CHINA
SEA
RYUKYU
ISLANDS
Okinawa
PACIFIC OCEAN
VOLCANO
ISLANDS
Iwo Jima
20°
MARIANA
ISLANDS
Saipan
Tinian
Guam
THE ATOMIC BOMBING
OF JAPAN
August 1945
Hiroshima bombing route, 6 Aug 45
Nagasaki bombing route, 9 Aug 45
Site of bomb drop
0
100
200
300
400 MILES

MAP 7

At the end of March, General Groves sent the District's deputy engineer, Col. Elmer E. Kirkpatrick, Jr., a long-time associate of the Manhattan commander on Army construction projects, to the Marianas as his personal representative with the mission of expediting delivery of the bomb components to Tinian and making sure that all essential construction work there was completed on schedule. Groves had brought Kirkpatrick to the project the previous September for the specific purpose of preparing him to monitor development of the overseas operational base. Thus, in the guise of a special assistant to Groves, he had spent considerable time at Los Alamos, Wendover Field, and Kirtland Field (near Albuquerque), assisting in inspection of bomb prototypes, observing the training of the 509th Composite Group, and helping to plan shipment of essential equipment and bomb components to Tinian.[14]

As soon as Kirkpatrick arrived on Guam, he went to Admiral Nimitz with a letter of introduction from Chief of Naval Operations Admiral Ernest J. King that explained his mission. Nimitz then assigned a member of his own staff, Capt. Thomas B. Hill, as Kirkpatrick's contact at CINCPOA headquarters. Kirkpatrick also delivered a similar letter from General Arnold to Maj. Gen. Curtis LeMay, commanding general of the XXI Bomber Command. To maintain the secrecy of his mission, Kirkpatrick was identified simply as a special representative from the War Department General Staff to the Twentieth Air Force and its XXI Bomber Command, reporting to General LeMay. He was carried as an assistant operations officer of the bomber command and quartered with the 313th Bombardment Wing, located at the same field on Tinian that would be used by the 509th Composite Group.[15]

Kirkpatrick devoted April and May to expediting facilities construction. A typical problem was a delay in unloading ships at Tinian harbor. Kirkpatrick notified Groves, who went to Admiral Purnell. The Navy representative on the Military Policy Committee obtained an order from Admiral King to Nimitz that all material for the 509th must be unloaded as soon as it reached Tinian. Another problem arose in constructing facilities on Iwo Jima for transferring an atomic bomb from one B-29 to another, in

[14] Historical Notes . . . , Incl to Ltr, Kirkpatrick to OCEHD, 30 Sep 68, OCEHD; List of Duties . . . of Liaison Off to 509th Comp Gp, Incl to Memo, Maj John A. Derry (Groves's Asst for Proj Opns) to Groves, sub: Discussion of 5 Mar With Norstad, 10 Mar 45, OCG Files, Gen Corresp, MP Files, Fldr 5, Tab C, MDR; Groves, *Now It Can Be Told*, p. 279. Colonel Kirkpatrick first worked with Groves in the Construction Division of the Quartermaster Corps. He came to the Corps of Engineers when the Construction Division was transferred to the Engineers in December 1944.

[15] Historical Notes . . . , Incl to Ltr, Kirkpatrick to OCEHD, 30 Sep 68, OCEHD; Memo, Groves (to Nimitz), 8 Mar 45, sub: Preparation and Movement of Personnel and Equipment to Tinian, OCG Files, Gen Corresp, MP Files, Fldr 5, Tab C, MDR. Groves states in a note at the bottom of page 1 of this memorandum that he had intended to show it in person to Nimitz, who was in Washington attending strategy meetings on the war in the Pacific, but he was unsuccessful in securing an appointment. Consequently, at Groves's direction, Colonel Kirkpatrick memorized the contents of the memorandum before leaving on his trip to the Marianas and subsequently passed on the information to Nimitz at a meeting on Guam in early April. See also Craven and Cate, *The Pacific*, pp. 706-07. The Air Force historians mistakenly identify Kirkpatrick as a "Twentieth Air Force engineer."

the event a bomber en route to Japan should have to make an emergency landing there. Kirkpatrick had arranged to have these facilities completed by 1 July, but an inspection by a project officer there as of that date revealed that virtually nothing had been done. Kirkpatrick informed Captain Hill, and prompt action was taken.[16]

In early May, Kirkpatrick came back to the United States for conferences with Groves and with personnel working on design and delivery of the bomb. He visited Captain Parsons at Los Alamos and other project officials there and at Wendover Field and the Inyokern test site. When Kirkpatrick returned to Tinian toward the end of the month, he found the first elements of the 509th arriving there. The group brought with it a number of C–54 transport planes, which were soon operating as a continuous shuttle service to the United States mainland, greatly facilitating movement of personnel and urgently needed equipment. By mid-July, all elements of the group had reached Tinian, including the 1st Technical Detachment comprised chiefly of civilian specialists from Los Alamos, some of whom had been brought temporarily into military service. Commanded by Parsons, the detachment furnished and tested weapon components for the 509th, supervised assembly of bombs, and checked out completed units, carefully inspecting them in bomb bays before planes took off. Frequent communication with Los Alamos threatened project security, so Groves dispatched Lt. Col. Peter de Silva, chief security officer at Los Alamos, to Tinian to establish effective security measures for the detachment, and John H. Manley, a Los Alamos physicist, to Washington, D.C., to serve as point of transmission for all project messages to Tinian.[17]

COL. ELMER E. KIRKPATRICK, JR.

Meanwhile, the 509th's combat crews were undergoing intensive flight training. This involved practicing navigation missions to Iwo Jima and making bomb runs to nearby islands still in enemy hands, using high-explosive projectiles with Fat Man's pumpkin shape. At the end of

[16] Historical Notes . . . , Incl to Ltr, Kirkpatrick to OCEHD, 30 Sep 68, OCEHD; Groves, *Now It Can Told*, pp. 280–81.

[17] Historical Notes . . . , Incl to Ltr, Kirkpatrick to OCEHD, 30 Sep 68, OCEHD; Memo, Kirkpatrick to Groves, 26 May 45, Admin Files, Gen Corresp, 201 (Gen), MDR; Memo, de Silva to Lt Col John Lansdale, Jr. (Groves's Spec Asst for Scty), 28 Jun 45, Admin Files, Gen Corresp, 371.2 (Scty), MDR; Groves Diary, 10 May and 31 Jul 45, LRG; MDH, Bk. 8, Vol. 2, pp. XIX.5–XIX.8, DASA; Groves, *Now It Can Be Told*, pp. 282–83.

training, which lasted three weeks, the crews in late July began a series of combat strikes over Japan to gain familiarity with target areas and mission tactics and also to accustom the Japanese to the appearance of small formations of B-29's flying at a great height. Using the pumpkin-shaped bombs, the 509th achieved excellent results against enemy towns, most of which had been hit by previous B-29 strikes. These towns—Koriyama, Nagaoka, Toyama, Kobe, Yokkaichi, Ube, Wakayama, Maizuru, Fukushima, and Niihama—were in the general vicinity of those communities selected earlier as targets for atomic bombing.[18]

The Bombing Targets

In the late spring and early summer of 1945, Manhattan and AAF representatives met in Washington and Los Alamos for the purpose of choosing targets for the 509th's atomic bombing mission. Normally the selection of specific bombing targets was a responsibility of the highest echelons in a theater of war. But in April, after briefing President Truman on the atomic program, General Marshall decided that the nature of Manhattan's security requirements and its inherently unique technical problems made it imperative for project leaders to have a major voice in the choice of targets, subject to final approval by himself and the Secretary of War. Hence, instead of assigning the task to the War Department General Staff's Operations Division, the Army Chief of Staff turned over this responsibility to General Groves.[19]

Although the Manhattan commander had not anticipated Marshall's decision, he moved immediately to carry out his new responsibility. After conferring with General Arnold, he and General Norstad selected a target committee. The committee included two members of Groves's staff (General Farrell, who served as *de facto* chairman when Groves was not present, and Major Derry), an AAF officer (Col. William P. Fisher), and five technical experts (John von Neumann, Robert R. Wilson, and William G. Penney, a member of the British team at Los Alamos, all from the Manhattan Project, and Joyce C. Stearns and David M. Dennison from the AAF.[20]

At the opening meeting of the target committee on 27 April, Groves briefed its members, first emphasizing the need for the highest degree of secrecy in its deliberations and then laying down some general guidelines for selection of targets. He suggested that they choose four targets and indicated that General Marshall had pointed out that ports on the west coast of Japan, vital to that country's communications with the Asiatic mainland, should not be overlooked. General Norstad then told the committee that the Twentieth Air Force would provide it with whatever support it needed, including related

[18] Craven and Cate, *The Pacific*, pp. 708-09; Ms, "Hist 509th Comp Gp," pp. 50-55 and 58-61, SHRC; Memo, de Silva to Lansdale, 28 Jun 45, Admin Files, Gen Corresp, 371.2 (Scty), MDR.

[19] Groves Diary, 23 Apr 45, LRG; Groves, *Now It Can Be Told*, pp. 266-67.

[20] Groves Diary, 23 Apr 45, LRG; Groves, *Now It Can Be Told*, pp. 266-68; Hewlett and Anderson, *New World*, p. 365.

information, operational analyses, maps, and targets data.[21]

The second committee meeting took place on 10 May in Los Alamos, where committee members had an opportunity to hear from the scientists and technicians who had worked on the bomb. At the third meeting in Washington on 28 May, Colonel Tibbets and Commander Ashworth, who had returned from Tinian for consultation, and scientific adviser Richard C. Tolman provided further data. The committee carefully considered various criteria: the maximum range for the loaded B-29 aircraft; the need for visual bombing; likely weather conditions; and expected damage. The last criterion weighed heavily on the committee, for it pointed up the necessity to select targets where the bomb would produce the maximum damage and hence have the profoundest impact upon enemy morale. Project scientists had indicated that the bomb would most likely achieve the desired results if it were dropped on densely built-up areas of significant value to the Japanese war effort. They also had emphasized that the targets should not have been bombed previously, so the effects might be assessed more accurately.[22]

Before concluding its 28 May meeting, the committee recommended four targets to General Groves, who promptly approved all of them. The choices were Kokura Arsenal, one of Japan's largest munitions plants, covering an area of 8 million square feet; Hiroshima, a major military embarkation port and convoy assembly point with a local army headquarters, railway yards, storage depots, and some heavy industrial plants; Niigata, an important seaport with significant industrial and commercial facilities, including an aluminum reduction plant, a large ironworks, an oil refinery, and a tanker terminal; and Kyoto, with a concentrated 3-square-mile industrial area and a population of about one million people. As soon as he received the committee's list, Groves prepared a plan of operations for General Marshall based upon the identified target choices.[23]

On 30 May, before delivering the plan of operations to General Marshall, Groves visited the Secretary of War on other business. The Secretary used the opportunity to query the Manhattan commander on the target choices. As soon as Groves mentioned Kyoto, Stimson expressed strong objection, noting that the city had been the ancient capital of Japan and was a place of great religious and cultural significance to the Japanese. Groves pointed out that Kyoto's large population and military and industrial importance made it an exceptionally suitable target, but the Secretary of War held fast to his views.

The target committee, nevertheless, did not find an immediate substitute for Kyoto. General Arnold included it

[21] Groves Diary, 27 Apr 45, LRG; Notes on Target Committee Mtg, 27 Apr 45, OCG Files, Gen Corresp, MP Files, Fldr 5, Tab D, MDR.

[22] Notes on Target Committee Mtg, 27 Apr and 28 May 45, MDR; Ms, Manhattan Engineer District, "The Atomic Bombings of Hiroshima and Nagasaki," June 1946, pp. 5–8, LC; Groves, *Now It Can Be Told*, p. 270."

[23] Groves, *Now It Can Be Told*, pp. 272–73; Ltr, Norstad through Dep Cdr, Twentieth Air Force, to CG XXI Bomber Cmd, sub: 509th Comp Gp Spec Functions, 29 May 45, OCG Files, Gen Corresp, MP Files, Fldr 5, Tab C, MDR. This letter appears to contain the substance of Groves's plan of operations, including reference to three of the four committee target choices (Kokura Arsenal is missing).

in his instructions in early June to the Twentieth Air Force to withhold conventional bombing of the four selected targets. So did Groves in late June, when he requested General Marshall to inform General Douglas MacArthur and Admiral Nimitz to refrain from attacking the target cities, but probably with the intention of making certain that Kyoto was not subjected to ordinary bombing. The Manhattan commander endeavored to change Stimson's mind on a number of occasions, but the Secretary remained adamant. Finally, on 21 July, Stimson, who was in Germany attending the Potsdam Conference, received a cable signed by special assistant George L. Harrison but certainly inspired by Groves: "All your local military advisors engaged in preparation definitely favor your pet city and would like to feel free to use it as first choice if those on the ride select it out of 4 possible spots in the light of local conditions at the time." [24] After conferring with President Truman, Stimson replied: "Give name of place or alternate places, always excluding the particular place against which I have decided. My decision has been confirmed by highest authority." [25] When the atomic bomb directive was issued to the United States Army Strategic Air Forces (USASTAF) on 25 July, Nagasaki had replaced Kyoto on the target list.[26]

The Decision To Use the Bomb

Meanwhile, the question of military employment of the bomb against Japan came up for consideration by the Interim Committee, a temporary body appointed by Stimson in May 1945 at the urging of project leaders and with the approval of the President. The committee's function was to advise and report on atomic energy matters. Membership was comprised of the Secretary of War, as chairman; George Harrison, as alternate chairman; former War Mobilization Director James F. Byrnes, representing the President; Vannevar Bush; James B. Conant; MIT President Karl T. Compton; Assistant Secretary of State for Economic Affairs William L. Clayton; and Under Secretary of the Navy Ralph A. Bard. At its first meeting on the ninth, Stimson outlined the parameters of the committee's broad authority—from advising on wartime controls and publicity releases to making recommendations on postwar policies concerning research, development, and control of atomic energy (including legislation). He did not mention that the committee would also advise on the military use of the bomb, but the interrelationship between this aspect of atomic energy and war and postwar controls made

[24] Msg, Harrison to Stimson, 21 Jul 45, CM-OUT-35987, OCG Files, Gen Corresp, MP Files, Fldr 5E, Tab A, MDR.

[25] Msg, Stimson to Harrison, 23 Jul 45, CM-IN-23195, OCG Files, Gen Corresp, MP Files, Fldr 5E, Tab C, MDR.

[26] Ltr Directive, Gen Thomas T. Handy (Act Chief of Staff) to Gen Carl A. Spaatz (CG USASTAF), 25 Jul 45; Memo, Groves to Norstad, 30 May 45; Memo, Groves to Chief of Staff, 30 Jun 45. All in OCG Files, Gen Corresp, MP Files, Fldr 5, Tab B, MDR. Stimson Dairy, 30 May, 6 Jun, 22 and 24 Jul 45, HLS. In the entry of 30 May, Stimson mentions the conference on S-1 but says nothing about targets. Groves Diary, 30 May 45, LRG. Stimson and Bundy, *On Active Service*, p. 625. Groves, *Now It Can Be Told*, pp. 273-76. Nagasaki, the city substituted for Kyoto on the bomb target list, was a major military port—one of Japan's largest shipbuilding and repair centers—and a producer of naval ordnance.

GENERAL GROVES CHECKING LOCATION OF BOMBING TARGETS

its involvement in that decision almost inevitable.[27]

At its next meeting on the fourteenth, the Interim Committee established a scientific panel, comprised of Oppenheimer, Fermi, Arthur Compton, and Lawrence. This group presented its views on the technical and political aspects of atomic energy at the fourth meeting of the committee on the thirty-first, which Generals Groves and Marshall attended. While recognizing that use of the bomb was essentially a military matter, the panel members nevertheless offered their opinions concerning the way it should be employed and the likely effects it would have on the targets selected. Oppenheimer closed the panel's briefing by emphasizing that the atomic bomb would have a different impact from any previous weapon because "the visual effect . . . would be tremendous, it would be accompanied by a brilliant luminescence which would rise to a height of 10,000 to

[27] See Ch. XXVII for a detailed discussion of the Interim Committee's activities in the preparation of press releases and public statements, and in planning for postwar controls and legislation. On the committee's organization and first meeting see Stimson Diary, 25 Apr and 2–3 and 8–9 May 45, HLS; Memo, Bundy to Secy War, 3 Mar 45, OCG Files, Gen Corresp, MP Files, Fldr 9, Tab A, MDR; Groves Diary, 9 May 45, LRG. See also in MDR, HB Files, the following: Notes on Interim Committee Mtgs, 9 and 17 May 45, Fldr 100; Interim Committee Log, 9 May 45, Fldr 98; Ltrs, Secy War to Conant, 4 May 45, and Conant to Secy War, 5 May 45, Fldr 69; Memo, Harrison to Secy War, sub: Interim Committee on S-1, 1 May 45, Fldr 69.

20,000 feet, [and] the neutron effect . . . would be dangerous to life for a radius of at least two-thirds of a mile."

Taking a moment to reflect on the discussion of targets and effects, Secretary Stimson proffered the conclusion that the atomic bomb should be used against Japan with no advance warning and, while not restricting the target to a civilian area, should be employed in such a way as "to make a profound psychological impression on as many of the inhabitants as possible." Both committee and panel members generally agreed, and the discussion continued. Conant suggested that the "most desirable target would be a vital war plant employing a large number of workers and closely surrounded by workers' houses," and Stimson indicated that was the type of target he also visualized. When Oppenheimer proposed that several simultaneous strikes would be feasible, Groves strongly objected. Such tactics, he stated, would eliminate the possibility of "gaining additional knowledge of the new weapon at each successive bombing . . . , would require a rush job on the part of those assembling the bombs and might, therefore, be ineffective, [and] the effect would not be sufficiently distinct from . . . regular Air Force bombing. . . ." [28]

Panel members left the 31 May meeting with the Secretary's instructions that they should prepare suggestions on postwar organization, research, and development for the Interim Committee. Arthur Compton was very much aware that there was great concern and substantial difference of opinion among Metallurgical Laboratory scientists on how to deal with postwar problems and programs. And in the interest of maintaining the morale of his scientific staff, he requested suggestions from them on the future of atomic energy, which he might then pass on to the scientific panel.

Among the various reports Compton received in the following two weeks was one prepared by a group of scientists under the leadership of James Franck, an outstanding German-refugee physicist who had come to the Metallurgical Laboratory from the staff of the University of Chicago. Centering on the political and social ramifications of an atomic bombing, the Franck report favored eventual international control of atomic energy as the only safe solution. Using the bomb against Japan without adequate warning, the report cautioned, would arouse great animosity against the United States and isolate her morally among the nations of the world, making establishment of international controls much more difficult. As an alternative, the report advocated a demonstration of the bomb in an uninhabited area, pointing out that this action would not prevent later military use of the bomb against Japan, if this were necessary. [29]

[28] Quotations in this and the preceding paragraph from Notes on Interim Committee Mtg, 31 May 45, MDR. See also Memo, 1st Lt R. Gordon Arneson (Interim Committee Secy) to Harrison, 6 Jun 45, HB Files, Fldr 100, MDR; Hewlett and Anderson, *New World*, pp. 356–59.

[29] The Franck report, signed by Franck and six of his fellow scientists at the Metallurgical Laboratory (David J. Hughes, James J. Nickson, Eugene Rabinowitch, Glenn Seaborg, Joyce Stearns, and Leo Szilard), was published under the title "Before Hiroshima" in *Bulletin of the Atomic Scientists*, 1 May 46. See also Compton, *Atomic Quest*, pp. 233–36; Hewlett and Anderson, *New World*, p. 366.

Some members of the Franck group did not feel that they could depend upon the scientific panel to bring their views to the attention of government leaders, so Franck himself carried the report to the capital. There, Arthur Compton saw to its delivery on 12 June to George Harrison's office at the War Department. Harrison, acting in his capacity as alternate chairman of the Interim Committee, decided that the Franck report should be turned over to the scientific panel for possible inclusion in the latter's own report on the use of the bomb.

Both the Franck report and the scientific panel's report were discussed at the meeting of the Interim Committee on the twenty-first. In contrast to the Franck report's recommendation that the bomb be used first in a technical demonstration made public to other countries, the panel's report—which acknowledged the differing views of project scientists on how the bomb should be employed—concluded that it could "propose no technical demonstration likely to bring an end to the war . . . [and] see no acceptable alternative to direct military use." [30] After considering the panel's views, the Interim Committee reaffirmed its earlier position "that the weapon be used against Japan at the earliest opportunity . . . without warning, and . . . on a dual target, namely a military installation or war plant surrounded by or adjacent to homes or other buildings most susceptible to damage." [31]

On 21 July, Stimson received not only Groves's detailed report on the successful test at Trinity, delivered by special courier, but also cables from Harrison indicating that atomic bombs would be ready sooner than expected. He promptly passed the word to American and British leaders at Potsdam, including President Truman, Prime Minister Churchill, Secretary of State Byrnes (as of 3 July), General Marshall, and Lord Cherwell, all of whom were elated by the news. On the twenty-fourth, Stimson showed the President the tentative plan of operations, which Groves had prepared and which he (Stimson) had received the day before from Harrison. This plan called for the first atomic bombing mission any time after 1 August, subject to completion of preparations and suitable weather. Truman accepted the plan without reservation, for, Stimson recalled, "that was just what he wanted. . . ." [32]

[30] Rpt, Scientific Panel, sub: Recommendations on the Immediate Use of Nuclear Wpns, 16 Jun 45. This report, one of three prepared by the panel on various aspects of the control and employment of atomic energy, is attached to Ltr, Oppenheimer (for Scientific Panel) to Secy War, Attn: Harrison, 16 Jun 45, OCG Files, Gen Corresp, Groves Files, Fldr 3, Tab T, MDR.

[31] Notes on Interim Committee Mtg, 21 Jun 45, MDR; Ltr, Compton to Stimson, 12 Jun 45, and Incl (unsigned copy of Franck report), OCG Files, Gen Corresp, Groves Files, Fldr 3, Tab T, MDR; Interim Committee Log, 12 and 15–16 Jun 45, HB Files, Fldr 98, MDR; Compton, *Atomic Quest*, pp. 233–36 and 239–41; Hewlett and Anderson, *New World*, pp. 365–69.

[32] Stimson Diary, 16–19 and 21–24 Jul 45 (quotation from 24 July), HLS. Memo, Groves to Secy War, sub: The Test, 18 Jul 45, HB Files, Fldr 49, MDR. Msgs, Harrison to Secy War, 21 Jul 45, CM-OUT-35988, Tab B; Secy War to Harrison, 23 Jul 45, CM-IN-23487, Tab C; Harrison to Secy War, 23 Jul 45, CM-OUT-36792 and CM-OUT-37350, Tab A, OCG Files, Gen Corresp, MP Files, Fldr 5E, MDR (copies in HB Files, Fldr 64, MDR). Groves, *Now It Can Be Told*, pp. 309–10. Truman later recalled that he had reached a decision in favor of using the atomic bomb on the basis of recommen-

Continued

On 25 July, General Marshall submitted to Stimson the draft of the USASTAF directive to proceed with the atomic bombing of Japan, and the Secretary—with assurance that all the Allied leaders favored going ahead with employment of the bomb—approved it. The directive carefully spelled out the procedures that were to govern the atomic bombing mission:

1. The 509 Composite Group, 20th Air Force will deliver its first special bomb as soon as weather will permit visual bombing after about 3 August 1945 on one of the targets: Hiroshima, Kokura, Niigata and Nagasaki. To carry military and civilian scientific personnel from the War Department to observe and record the effects of the explosion of the bomb, additional aircaft will accompany the airplane carrying the bomb. The observing planes will stay several miles distant from the point of impact of the bomb.

2. Additional bombs will be delivered on the above targets as soon as made ready by the project staff. Further instructions will be issued concerning targets other than those listed above.

3. Dissemination of any or all information concerning the use of the weapon against Japan is reserved to the Secretary of War and the President of the United States. No communiques on the subject or release of information will be issued by Commanders in the field without specific prior authority. Any news stories will be sent to the War Department for special clearance.

4. The foregoing directive is issued to you by direction and with the approval of the Secretary of War and of the Chief of Staff, USA. It is desired that you personally deliver one copy of this directive to General MacArthur and one copy to Admiral Nimitz for their information.[33]

Dropping the Bomb

Manhattan played an important supporting role in the AAF's execution of the 25 July directive. At the top level, General Groves continued to retain a voice in the general direction of the mission, through his access to General Arnold's staff in Washington, through his two representatives on Tinian (Colonel Kirkpatrick and, as of 31 July, General Farrell) and through Admiral Purnell, whom Admiral King had assigned to coordinate the bombing with Navy commanders in the Pacific Theater.[34]

General Farrell arrived in the Central Pacific area with specific instructions from Groves: to coordinate ongoing preparations for dropping the first atomic bomb on Japan. Farrell first stopped on Guam, where he conferred with General LeMay, who would shortly become USASTAF

dations of his military advisers and after Churchill had told him at Potsdam that he was convinced it should be employed "if it might aid to end the war" (see Harry S. Truman, *Memoirs*, 2 vols. [Garden City, N.Y.: Doubleday and Co., 1955–56], 1:419). Truman subsequently informed Air Force historians that he actually gave the order for dropping the bombs on Hiroshima and Nagasaki in the mid-Atlantic while returning to the United States from Potsdam on board the cruiser USS *Augusta* (2–7 Aug 45). See Ltr, Truman to Cate, 12 Jan 53, reproduced in Craven and Cate, *The Pacific*, between pp. 712–13. For a further discussion on the decision to use the bomb see Louis Morton, "The Decision To Use the Atomic Bomb," in *Command Decisions*, ed. Kent Roberts Greenfield (Washington, D.C.: Government Printing Office, 1960), pp. 493–518.

[33] Ltr Directive, Handy to Spaatz, 25 Jul 45, MDR. A copy of the original directive is reproduced in Craven and Cate, *The Pacific*, following page 696. See also Groves, *Now It Can Be Told*, pp. 308–09.

[34] Groves, *Now It Can Be Told*, p. 311; Memo, Groves to Chief of Staff, sub: Plan of Opns–Atomic Fission Bomb, 24 Jul 45, OCG Files, Gen Corresp, MP Files, Fldr 25, Tab P, MDR; Groves Diary, 24–26 and 31 Jul 45, LRG; Rpt, Farrell, sub: Overseas Opns–Atomic Bomb, ca. 15 Sep 45, Admin Files, Rpts Pertaining to the Effects of the Atomic Bomb, Farrell, MDR; Testimony of Farrell in *Atomic Energy Hearings on S. Res. 179*, p. 502.

COL. PAUL W. TIBBETS, JR. (*center*), WITH GROUND CREW AT TINIAN

chief of staff, and with Admiral Nimitz. Moving on to Tinian, Farrell visited Admiral Purnell and Captain Parsons.[35]

Farrell spent considerable time with Parsons, who talked at length about the intensive activities of the 1st Technical Detachment on Tinian during the month of July. The detachment, with assistance from other elements of the 509th and the Navy, had installed the technical facilities required for assembly and testing of bomb components, especially with Little Boy, and had carefully checked out the emergency reloading facilities at Iwo Jima. Parsons also informed Farrell about the function of his newly formed project technical committee, namely, to assist him in planning and coordinating with AAF elements the complex final tests and assembly of both the gun-type and implosion weapons.[36]

[35] Rpt, Farrell, sub: Overseas Opns–Atomic Bomb, ca. 15 Sep 45, MDR; Historical Notes . . . , Incl to Ltr, Kirkpatrick to OCEHD, 30 Sep 68, OCEHD.

[36] Memo, E. J. Doll (Delivery Gp, Tinian) to Parsons, sub: Summary of Spec Mtg (24 Jul 45) of Wpns Committee, 27 Jul 45; Memo, Norman F. Ramsey (Delivery Gp, Tinian) to Parsons, sub: Summary of Spec Mtg (27 Jul 45) of Proj Tech Committee, 28 Jul 45, and Incl (Table 1, Schedule of Events); ibid., sub: Summary of Mtg (30 Jul 45) of Proj Tech Committee, 6 Aug 45. All in OCG Files,

Continued

Component parts and active material for both types of atomic bombs reached the detachment on Tinian only shortly before they were actually used in bombing missions. Those for Little Boy arrived first. Most of its components and the U-235 had left Los Alamos in mid-July in custody of Maj. Robert R. Furman, a special projects officer from Groves's Washington headquarters, and Capt. James F. Nolan, chief medical officer at the New Mexico installation. They traveled by automobile from Santa Fe to Albuquerque, by airplane to Hamilton Field near San Francisco, thence to Hunters Point to board the cruiser *Indianapolis*. Crossing the Pacific in record time, they reached Tinian on 26 July.[37] Two Los Alamos security officers brought the remaining components and the rest of the active material for Little Boy aboard two C-54 cargo aircraft, the first arriving at Tinian on the twenty-eighth and the second on the following day.[38]

The 509th technical teams quickly assembled the Little Boy unit, and Parsons requested permission from Groves to drop it as early as 1 August. But weather conditions for the first four days of the month were unsuitable. During this period, the technical teams and bombing crews worked on an around-the-clock basis, perfecting plans for delivering Little Boy and carrying out tests on Fat Man rehearsal units. At the same time, components for the Fat Man arrived at Tinian aboard two B-29's that Groves had held at Albuquerque for that purpose and plutonium active material came in aboard a C-54.[39]

Finally, on the morning of the fifth, AAF meteorologists indicated that visual bombing should be possible over the target cities on the following day, and General LeMay directed that the Littly Boy mission would take place on the sixth. Technical teams loaded the bomb in the *Enola Gay* B-29 aircraft and completed the final testing of the unit. A few days earlier bomb technicians had worked out a method for reducing the danger of a premature explosion by delaying final arming until the aircraft was airborne. Captain Parsons, who was to go on the flight as the bomb commander, had responsibility for performing this function.

The final briefing took place at midnight, and the weather planes departed for the target area. Hiroshima was the primary target, Kokura second, and then Nagasaki (*see Map 7*). In the meantime, a C-54 had carried Colonel Kirkpatrick and a crew from the technical group to Iwo Jima to stand by to transfer the bomb to a spare B-29 if the strike aircraft had to land there.[40]

Tinian Files, Env B, 200 (Kirkpatrick), MDR. See also MDH, Bk. 8, Vol. 2, pp. XIX.7-XIX.8, DASA.

[37] A Japanese submarine sank the ill-fated *Indianapolis* four days later en route to the Philippines. See Richard F. Newcomb, *Abandon Ship! Death of the USS Indianapolis* (New York: Holt, Rinehart and Winston, 1958).

[38] MDH, Bk. 8, Vol. 2, pp. XIX.8-XIX.9, DASA; Groves, *Now It Can Be Told*, pp. 305-08; Craven and Cate, *The Pacific*, pp. 714-15; Testimonies of Groves and physicist Philip Morrison (Los Alamos Lab) in *Atomic Energy Hearings on S. Res. 179*, pp. 39-40 and 234-35.

[39] MDH, Bk. 8, Vol. 2, pp. XIX.8 and XIX.10, DASA; Rpt, Farrell, sub: Overseas Opns-Atomic Bomb, ca. 15 Sep 45, MDR; Historical Notes . . . , Incl to Ltr, Kirkpatrick to OCEHD, 30 Sep 68, OCEHD; Groves Diary, 4 Aug 45, LRG; Memo, Groves to Chief of Staff, 6 Aug 45, OCG Files, Gen Corresp, MP Files, Fldr 5, Tab B, MDR.

[40] MDH, Bk, 8, Vol. 2, XIX.8-XIX.9, DASA; Memo, Groves to Chief of Staff, 6 Aug 45, MDR;

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ENOLA GAY AT TINIAN

At 0245 (Tinian time) on 6 August, with Little Boy in her bomb bay and Colonel Tibbets at the controls, the *Enola Gay* lifted off the Tinian runway, followed at two-minute intervals by two observation planes carrying recording instruments and scientific observers, most of them from the Manhattan Project. Tibbets' instructions were to choose the target on the basis of reports from the weather planes—Hiroshima was preferred because it was the one target that had no American prisoner-of-war camp—and, if all were closed in, to return with the bomb.[41]

Captain Parsons kept the log of the flight that described in terse phrases the progress of the historic mission:

0300 Started final loading of gun.
0315 Finished loading.
0605 Headed for the Empire from Iwo.
0730 Red plugs in [these plugs armed the bomb so it would detonate if released].
0741 Started climb. Weather report received that weather over primary and tertiary targets was good but not secondary target.
0838 Leveled off at 32,700 feet.
0847 All Archies [electronic fuses] tested to be OK.
0904 Course west.

Historical Notes . . . , Incl to Ltr, Kirkpatrick to OCEHD, 30 Sep 68, OCEHD; Craven and Cate, *The Pacific*, p. 176

[41] At the end of July, General Spaatz had cabled General Groves, calling attention to the reported location of prisoner-of-war camps near some of the target areas selected for atomic bombing and requesting advice on how this should affect his orders to the 509th Composite Group. Groves consulted with General Handy, the Acting Chief of Staff, and they agreed that Spaatz should be told to disregard the purported presence of prisoner-of-war camps in issuing his orders. Handy, however, believed that Stimson should be informed of this policy. Accordingly, Groves showed the Secretary of War both the cable from Spaatz and his reply to the USASTAF commander. Stimson, by taking no action, in effect approved the policy. See Groves, *Now It Can Be Told*, pp. 312–13.

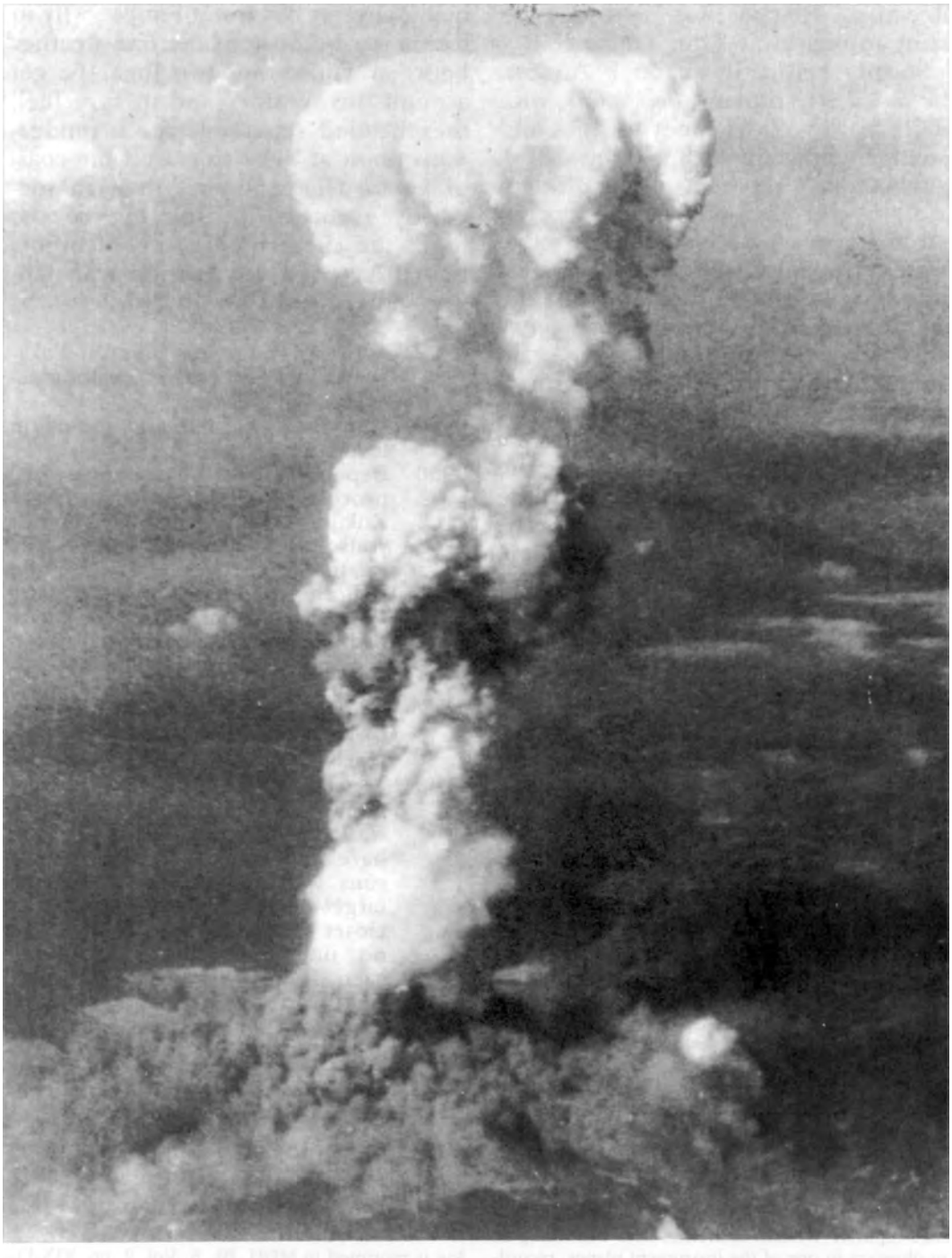
0909 Target [Hiroshima] in sight.
0915½ Dropped bomb [Originally scheduled time was 0915]. Flash followed by two slaps on plane. Huge cloud.
1000 Still in sight of cloud which must be over 40,000 feet high.
1003 Fighter reported.
1041 Lost sight of cloud 363 miles from Hiroshima with the aircraft being 26,000 feet high.[42]

About fifteen minutes after the bomb was dropped, Parsons radioed back to Farrell on Tinian in a special code: "Results clear cut, successful in all respects. Visible results greater than Trinity. Conditions normal in airplane following delivery. Proceeding to Tinian." Farrell promptly relayed this first report to Groves, waiting anxiously in Washington, but because of unexplained communications delays, it did not reach him until 11:30 P.M. (Washington time), 5 August, more than four hours after the dropping of the bomb. At 4:30 the next morning Groves received a detailed cable from Farrell, dispatched after return of the *Enola Gay* to Tinian. This cable became the basis of Groves's report to General Marshall at the Pentagon and, by telephone, to Stimson at home. Farrell's, cable also provided most of the confirmation Groves needed to clear for release to the press the President's statement, prepared earlier by the Interim Committee. The one point on which the cable lacked sufficient information was the amount of damage inflicted on Hiroshima. To avoid any chance of overstatement that might reduce the announcement's effect on the Japanese, Groves obtained from General LeMay on Guam assurance that the bomb appeared to have caused enormous destruction. Then at 11:00 A.M. the President's press secretary (Truman was still en route home from Potsdam) released the statement to the waiting newsmen at the White House, giving the American people their first news of the atomic bombing of Japan and of the wartime project that made it possible.[43]

Meanwhile on Tinian, the 509th's weapon assembly teams prepared for the first Fat Man mission, scheduled for 11 August. Rapid progress with assembly of the implosion unit led Parsons to propose to Tibbets on the seventh that the mission be moved up to the tenth. But forecasts indicated that a period of bad weather was due to begin on the tenth and last for five days. Would it be possible, Tibbets asked Parsons, to have the bomb ready by the ninth? Parsons expressed uncertainty as to whether the bomb could be safely readied in so short a time, but agreed to try. Working without letup, the technical teams succeeded in assembling, loading, and checking the unit by the evening of the eighth. Kokura was the primary target and Nagasaki, the secondary

[42] The log is reproduced in MDH, Bk. 8, Vol. 2, XIX.9–XIX.10, DASA.

[43] Quote from Rpt, Farrell, sub: Overseas Opns–Atomic Bomb, ca. 15 Sep 45, MDR. Groves, *Now It Can Be Told*, pp. 320–31. Farrell's message to Groves is reprinted on page 323. Groves's report to Marshall on the bombing of Hiroshima is the memorandum of 6 Aug 45, filed in MDR, OCG Files, Gen Corresp, MP Files, Fldr 5, Tab B. The presidential statement is in *Harry S. Truman, 1945*, Public Papers of the Presidents of the United States (Washington, D.C.: Government Printing Office, 1961), pp. 197–200.



Mushroom Cloud Over Hiroshima

objective. Niigata was excluded as being too far away from Tinian.[44]

Shortly before dawn on 9 August, the B-29 strike plane *Bock's Car*, with Maj. Charles W. Sweeney as pilot and Commander Ashworth as the bomb commander, prepared to take off with two observer aircraft. Sweeney's original flight plan designated the same route to Japan via the Volcano Islands followed by the Hiroshima mission, again to provide for an emergency stop if needed on Iwo Jima. Again Colonel Kirkpatrick awaited with a bomb-loading team and a spare B-29. Just before lift-off, the *Bock's Car* crew discovered that the fuel pump for the plane's reserve gasoline tank in the bomb bay was not working properly. Normally such a mechanical problem would have aborted the mission. But faced with a prediction of worsening weather and knowing the importance to the Allied surrender negotiations with Japan of having a second atomic bomb attack closely follow the first, Farrell decided to risk going ahead with the mission.[45]

The defective fuel pump was only one of a number of difficulties that were to make the second atomic bombing mission as eventful as the first was routine. Taking off at about 0347,[46] the strike plane and accompanying aircraft did not attempt to fly in formation because of the bad weather between Tinian and Iwo Jima. To get around this weather and to save fuel, they headed separately for a rendezvous point at Yaku-shima off the coast of Japan. Commander Ashworth succinctly recorded in the log of the flight the succeeding series of events that threatened the mission with failure and very nearly with disaster:

0900 Arrived rendezvous point at Yakashima [*sic*] and circled awaiting accompanying aircraft.

0920 One B-29 sighted and joined in formation.

0950 Departed from Yakashima [*sic*] proceeding to primary target Kokura having failed to rendezvous with second B-29. The weather reports received by radio indicated good weather at Kokura (3/10 low clouds, no intermediate or high clouds, and forecast of improving conditions). The weather reports for Nagasaki were good but increasing cloudiness was forecast. For this reason the primary target was selected.

1044 Arrived initial point and started bombing runs on target. Target was obscured by heavy ground haze and smoke. Two additional runs were made hoping that the target might be picked up after closer observations. However, at no time was the aiming point seen. It was then decided to proceed to Nagasaki after approximately 45 minutes spent in target area.

At this point, Ashworth and Sweeney determined they had only enough gasoline to make a single bombing run over Nagasaki, if they were to reach the closest alternate landing

[44] MDH, Bk. 8, Vol. 2, XIX.10-XIX.11, DASA; Rpt, Farrell, sub: Overseas Opns-Atomic Bomb, ca. 15 Sep 45, MDR; Craven and Cate, *The Pacific*, pp. 718-19.

[45] Groves, *Now It Can Be Told*, p. 344.

[46] The 0347 takeoff time is recorded by Ashworth in the log of the mission. Other sources vary as to the precise moment of lift-off. Farrell states in his 15 September report that the time was 0348; Craven and Cate, the Air Force historians, fix it at 0349 (*The Pacific*, p. 719); and *New York Times* science reporter William Laurence, who was riding as an observer in one of the instrument planes, recorded it as 0350 (*Dawn Over Zero*, p. 231). Ashworth's log is reprinted in MDH, Bk. 8, Vol. 2, pp. XIX.11-XIX.12, DASA

field on Okinawa. More than one run would require ditching *Bock's Car*:

1150 Arrived in Nagasaki target area. Approach to target was entirely by radar. At 1150 the bomb was dropped after a 20 second visual bombing run. The bomb functioned normally in all respects.
1205 Departed for Okinawa after having circled smoke column. . . .
1351 Landed at Yontan Field, Okinawa.
1706 Departed Okinawa for Tinian.
2245 Landed at Tinian.

Ashworth radioed first word of the bombing of Nagasaki to Farrell on Tinian while *Bock's Car* was en route to Okinawa, indicating some uncertainty as to the results, although the visible effects appeared to him about equivalent to those at Hiroshima. On Okinawa, Ashworth consulted with all the crews and observers and concluded that the implosion bomb had been satisfactorily placed over the target. They reported that the flash was brighter, the shock waves greater, and the cloud was larger and moved up faster than at Hiroshima. But photographs taken four hours after the strike showed little because of the cloud, smoke, and dust cover. Only days later would additional photographs reveal that the entire industrial part of Nagasaki and a considerable part of the residential area had been destroyed.[47]

The Surrender of Japan

As soon as he received word of the successful bombing of Nagasaki, General Groves felt certain Japan's capitulation would follow. He went at once to see General Marshall to discuss future operations against Japan. They agreed that, in view of Stimson's policy of using the bomb only to end the war, shipment of materials for a third bomb should be delayed until 13 August. When by that date the Japanese still had not surrendered, neither the Secretary of War nor the Chief of Staff was available to Groves for consultation because of the continuing negotiations for an armistice. Groves then went to General Thomas T. Handy, Acting Chief of Staff, and informed him that he would order the continued holding of all fissionable materials in the United States, requesting Handy to pass this information on to Stimson and Marshall at the earliest opportunity. Meanwhile, project personnel at Los Alamos and on Tinian also continued in full readiness to prepare and deliver additional atomic bombs.[48]

The march of events vindicated Groves in his decision. On 14 August, President Truman received a message from the Japanese government that constituted full and satisfactory acceptance of the Allied terms of surrender, as set forth in the Potsdam Declaration. The judicious employment of atomic bombs in tandem with a series of warnings to the Japanese government of more to come if it did not yield had comprised the strategy in the final successful maneuverings for the surrender. To the average observer in the West in mid-1945, the Japanese decision to comply with Allied terms appeared to be the direct result of the atomic bombing of Hiro-

[47] For other accounts of the bombing of Nagasaki see Craven and Cate, *The Pacific*, p. 719–21; Laurence, *Dawn Over Zero*, pp. 228–43; Groves, *Now It Can Be Told*, pp. 344–46.

[48] Groves, *Now It Can Be Told*, pp. 352–53.

shima and Nagasaki, the Soviet Union's declaration of war against Japan on 9 August, and the Allied promise not to alter the legal position of Emperor Hirohito. Yet, with the advantage of hindsight and a detailed knowledge of developments within Japan in the weeks preceding the surrender, a leading historian on the subject makes clear that the "decision—in embryo—had long been taking shape." [49]

By the spring of 1945, the Japanese armed forces had brought the Empire to the brink of disaster. Broad public support for the military had begun to disintegrate as the people of Japan came to realize that the very survival of their country was threatened. When Premier Kantaro Suzuki replaced General Hideki Tojo in April, the government initiated a definite campaign to seek an end of the war on terms acceptable to the ruling elite. But this campaign, begun in June with efforts to open peace negotiations through the Soviet Union, was of little avail as long as the Japanese militarists dominated the government and the Allies were unwilling to guarantee the future status of the Emperor. Only the shock impact of the atomic bombings of Hiroshima and Nagasaki, combined with the Soviet entry into the war, created "that unusual atmosphere in which the theretofore static factors of the Emperor could be made active in such an extraordinary way as to work what was virtually a political miracle. . . . It was the nation's good fortune that, in spite of the existence of a hard-headed and strongwilled corps of fanatics, the men responsible for the movement to terminate the war were finally able, under the circumstances of 1945, to give the fullest possible effect to the depth of appeal in the voice of the man who is the supreme symbol in Japanese life and thought." [50]

The surrender of Japan on 14 August completed the mission of Manhattan's Project Alberta group, assigned to the 1st Technical Detachment, on Tinian. Most technical personnel of the Alberta group originally planned to return to the United States on the twentieth, leaving only a small team under General Farrell that was to go to Japan to investigate the results of the bombing. But when delays developed in arranging surrender procedures, General Groves requested that essential project personnel remain on Tinian pending successful completion of the occupation of Japan. Project Alberta scientists and technicians finally left Tinian on 7 September. Colonel Kirkpatrick and Commander Ashworth stayed behind to make final disposition of project property, taking special care to return to Los Alamos under guard or to dump in the sea any items likely to reveal information about the bomb. Some project property went with the investigating teams assembled under General Farrell, to be used in surveying the effects of atomic bombing on Hiroshima and Nagasaki.[51]

[49] Robert J. C. Butow, *Japan's Decision To Surrender* (Stanford, Calif.: Stanford University Press, 1954), p. 231.

[50] Ibid., pp. 231 and 233.

[51] For the official account of the closing out of Project Alberta see MDH, Bk. 8, Vol. 2, p. XIX.13, DASA.

Survey of the Bombing Effects

The swift surrender of Japan opened the way for American scientific teams to survey, on the ground, the specific effects of the atomic bombing of Hiroshima and Nagasaki. Not only were scientists, medical personnel, and professional military men greatly interested in learning the results of the first employment of atomic weapons in warfare, but also the commanders of the occupation troops that were scheduled shortly to move into the two bombed cities desired a check of the possible hazards with which they might have to cope. Although Manhattan scientists were virtually sure that detonation of the atomic bombs a considerable distance above the ground had eliminated the likelihood of any lingering large-scale radioactivity in the two cities, lacking previous experience they could not be certain without actual inspection of the affected areas.[52]

Thus, when General Groves heard from General Marshall on 10 August that the Japanese had started surrender negotiations, he took steps to organize Manhattan Project teams to carry out atomic investigations in Hiroshima and Nagasaki, as well as elsewhere in the home islands. On the eleventh, the Manhattan commander directed District Engineer Nichols to select qualified project personnel and procure the special equipment the teams would need to perform their mission. He also sent instructions to General Farrell that he was to be in command of the Manhattan survey teams going into Japan. Farrell began to assemble medical, scientific, and intelligence personnel already on Tinian to participate in the investigations. On the twelfth, three days before General MacArthur's appointment as Supreme Commander for the Allied Powers (SCAP), Japan, General Marshall informed him of the purpose of the survey groups, clearing the way for their early entry into Japan.

Meanwhile, Colonel Nichols, with assistance primarily from the medical staff of the District, hurriedly brought together fifteen officers and twelve

[52] This account of the effects of atomic bombs on Hiroshima and Nagasaki is based primarily upon the following sources: MDH, Bk. 1, Vol. 4, "Auxiliary Activities," Ch. 6 (Investigation of the After Effects of the Bombing in Japan), DASA; Ms, MED, "The Atomic Bombings of Hiroshima and Nagasaki," June 1946, LC; MED, "Photographs of the Atomic Bombings of Hiroshima and Nagasaki," June 1946, LC; Austin M. Brues et al., comps., *General Report of Atomic Bomb Casualty Commission, January 1947* (Washington, D.C.: National Research Council, 1947); The Committee for the Compilation of Materials on Damage Caused by the Atomic Bombs in Hiroshima and Nagasaki, ed., *Hiroshima and Nagasaki: The Physical, Medical, and Social Effects of the Atomic Bombings*, trans. Eisei Ishikawa and David L. Swain (New York: Basic Books, 1981); United States Strategic Bombing Survey, *The Effects of Atomic Bombs on Hiroshima and Nagasaki* (Washington, D.C.: Government Printing Office, 1946); *Atomic Energy Hearings S. Res. 179*, Nov 45–Feb 46; Statements by Yoshio Nishina (Institute of Physical and Chemical Research, Tokyo, Japan), 12 Aug 48 and 4 May 50, in Ms, Historical Division, Military Intelligence Section, General Headquarters, Far East Command, "Statement of Japanese Officials on World War II," copy in CMH. On medical aspects see Memo, sub: Toxic Effects of the Atomic Bomb, 12 Aug 45, OCG Files, Gen Corresp, MP Files, Fldr 5, Tab G, MDR; *Radiology in World War II*, pp. 831–919; Michihiko Hachiya, *Hiroshima Diary: The Journal of a Japanese Physician, August 6–September 30, 1945*, ed. and trans. Warner Wells (Chapel Hill, N.C.: University of North Carolina Press, 1955); Office of Civil Defense, Office of the Secretary of War (Japan), and Technical Management Office, U.S. Naval Radio, *Analysis of Japanese Nuclear Casualty Data*, comps. L. Wayne Davis et al. (Albuquerque, N.Mex.: Dikewood Corp., April 1966); United States Strategic Bombing Survey, Medical Division, *The Effects of Atomic Bombs on Health and Medical Services in Hiroshima and Nagasaki* (Washington, D.C.: Government Printing Office, 1947).

enlisted men from the Clinton Laboratories, Metallurgical Laboratory, Los Alamos, the Monsanto Chemical Company, and the University of Rochester. Comprised chiefly of medical scientists and individuals trained in taking radiation measurements, this group rendezvoused on the twelfth at Hamilton Field in California and departed for Tinian on the following day.

When the project's survey group reached Tinian on the sixteenth, they joined the group General Farrell had organized, which included not only Manhattan personnel but also several AAF representatives and two interpreters. Groves had designated Major Furman, who had participated in Manhattan's scientific intelligence activities in Europe, to lead a unit with a similar mission of investigating the progress of atomic research in Japan.

While the assembled survey personnel marked time in late August, General Farrell formed them into three teams. The first team going to Japan included Farrell himself, Brig. Gen. James B. Newman, Jr., of the AAF, who served as his deputy; medical and intelligence officers; and officers trained in metallurgy. In the other two teams, he included chiefly medical officers. Col. Stafford L. Warren, chief of the Manhattan District's Medical Section, commanded the Nagasaki group, while his deputy in the Medical Section, Lt. Col. Hymer L. Friedell, led the Hiroshima team.

Negotiations with the Japanese to arrange for an early entry into Hiroshima and Nagasaki culminated in formation of a special party, comprised mostly of medical personnel from the International Red Cross, the Army Medical Corps, MacArthur's staff, and the Manhattan Project. The Manhattan contingent consisted of Farrell, Newman, Warren (whom Farrell had relieved temporarily of his assignment as chief of the Nagasaki team so that he could serve as his medical consultant), and a medical and an intelligence officer. The special party, accompanied by two representatives of the Japanese government, flew into Hiroshima on 8 September. Using Geiger counters and other instruments, members of the party checked through the destroyed area of the city, determining that no significant amounts of radioactivity persisted. A Signal Corps photographer with the party took some of the first official pictures of the damage wrought by the bomb. Completing the preliminary survey in a few days, the special party (except for Farrell and Newman who had left earlier for a hurried visit to Nagasaki) returned to Tokyo.

Meanwhile, Colonel Warren's team reached Nagasaki on 17 September and began three weeks of intensive investigation of damage and injuries wrought by the bomb in that city. The group concentrated on gathering data concerning the nature of casualties. It examined survivors in the nearby Omura Naval Hospital and obtained autopsy records of those who were killed or died of injuries. A new detail of officers from the Army Medical Corps relieved Warren's team in early October, and it departed from Nagasaki on the sixth, arriving back in the United States on the fifteenth.

A series of typhoons prevented Colonel Friedell's team from reaching Hiroshima until 26 September. It had only about a week to carry out investi-

gations designed to supplement the preliminary data collected by Farrell's party. Departing Hiroshima on 3 October, Friedell's team joined the Nagasaki group for the return trip to the United States.

Other investigative groups, some of them sponsored by the Army, also conducted surveys of the effects of the atomic bombing of Japan in late 1945 and 1946. SCAP headquarters had established a Joint Commission for the Investigation of the Atomic Bombing of Japan during the period when the Manhattan Project survey was in progress. Commission teams comprised chiefly of Army medical personnel and Japanese scientists worked closely with the Manhattan teams, which were viewed as part of the commission's survey organization. The commission's personnel continued to work in Hiroshima and Nagasaki after the departure of the Manhattan teams, extending studies begun by the bomb project groups.

The Manhattan teams also cooperated with the group sent to Japan by the United States Strategic Bombing Survey (USSBS), an organization established by the War Department in 1944. The USSBS had received a request from the President in August 1945 to conduct a study of the effects of all types of air attack in the war against Japan, including the employment of atomic bombs. In addition, the Secretary of War retained Maj. Alexander de Seversky, a well-known aviator and aeronautics engineer, to serve as his special consultant on the results of employing air power in the Pacific Theater, including the atomic bombing of Hiroshima and Nagasaki. The Navy had its own special investigative unit, the Naval Technical Mission to Japan, which collaborated with Manhattan teams. The British Mission arrived too late to work with the Manhattan groups, but cooperated with the USSBS in surveys of Hiroshima and Nagasaki in November 1945.

All of the survey groups eventually published reports of their observations and conclusions concerning the effects of the atomic bombing of Hiroshima and Nagasaki. The Manhattan District released its report on 30 June 1946, summarizing the physical damage, medical findings, and other pertinent observations made by its survey teams.

Both cities had suffered extensive physical damage to structures and other inanimate objects as a result of the tremendous blast and conflagration, the latter caused by heat from the atomic explosion, collapse of buildings, overturned stoves, shorting out of electrical systems, and spread of fire. Within a radius of 1 mile of the epicenter of the explosion, destruction in both cities was virtually complete, except for the frames of a few reinforced concrete buildings. Because of differences in topography and layout of the cities, more than 5 square miles of Hiroshima were totally devastated, while only 3 square miles of Nagasaki were similarly destroyed. In the relatively flat terrain of Hiroshima there was heavy damage to almost everything up to 2 miles from the blast center, destruction of 50 percent or more up to 3 miles, and comparatively light damage for several miles beyond, with broken glass as far away as 12 miles. In the rougher terrain of Nagasaki, severe damage extended for about 3 miles north and south in the valley where

PHYSICAL DAMAGE AT HIROSHIMA

the bomb had been dropped and generally shorter distances up the hillsides to the east and west, but with partial damage or fire as far as 4 miles out from the blast center at certain points.

The various survey groups were able to obtain a reasonably accurate assessment of the actual physical damage, but they all experienced greater difficulty in securing a clear picture of the effect on the inhabitants of the two cities. The Manhattan teams, for example, were handicapped by the length of time that had elapsed before they were able to enter the cities. They also found that Japanese public officials lacked precise statistical data on the actual population of the two stricken communities at the time of the bombings and on the subsequent movement of people in and out of the cities. The extensive destruction of such record-keeping civil organizations as hospitals, fire and police departments, and other government agencies further complicated the collection of accurate statistics.

Thus, the Manhattan teams had to derive most of their medical data from examining the injured; analysis of death records, including autopsy reports; and tabulation of such data as the Japanese had compiled. The District released its survey results in June 1946, including the estimate of casualties that differed somewhat from those released by other groups (*Table 3*).

TABLE 3—COMPARATIVE ESTIMATES OF ATOMIC BOMBING CASUALTIES IN WORLD WAR II

City	Population 1945	MED June 1946		USSBS March 1947		OSW (Japan) and USNR April 1966	
		Dead	Injured	Dead	Injured	Dead	Injured
Hiroshima	255,000	66,000	69,000	80,000	80,000–100,000	70,000	70,000
Nagasaki	195,000	39,000	25,000	45,000	50,000–60,000	36,000	40,000
Total	450,000	105,000	94,000	125,000	130,000–160,000	106,000	110,000

Sources: Ms, MED, "The Atomic Bombings of Hiroshima and Nagasaki," June 1946, LC; USSBS, *The Effects of Atomic Bombs on Health and Medical Services in Hiroshima and Nagasaki*; OSW (Japan) and USNR, *Analysis of Japanese Nuclear Casualty Data.* See also MDH, Bk. 1, Vol. 4, pp 6.12–6.15, DASA.

Manhattan's survey data did not mention that American prisoners of war held in a camp in Hiroshima were among the atomic bombing casualties. The Commander in Chief, U.S. Army Forces, Pacific, had received information that about twenty American airmen from the crews of airplanes shot down over Japan were killed in the bombing of Hiroshima. Subsequent information provided by Japanese officials appeared to confirm the presence of the airmen in Hiroshima on 6 August 1945.[53]

A primary objective of the Manhattan survey teams was to ascertain the particular kinds of injuries suffered, with special attention to the effects of radioactivity. By far the largest number of casualties resulted from burns traceable to the heat of the explosion and the fires generated by it and secondary causes. Other major sources of injury were falling debris, pressure of the blast, and radiation. Most radiation injuries occurred from exposure of the victims to gamma rays at the time of the explosion. There was little evidence of casualties from alpha and beta rays and from residual radioactivity in the bombed-out areas.

While giving less attention to the psychological impact, the teams nevertheless ranked terror with physical damage and human death and injury as the three most important effects of the new weapon. They particularly noted the immediate panic caused by the explosions, followed by a temporary mass exodus from the cities. Residents who had generally ignored the appearance of only one or two enemy aircraft moved promptly into air raid shelters at the slightest indication of enemy air activity overhead.

The USSBS, unlike the Manhattan survey, devoted considerable effort to trying to determine the effects of the bombs on the attitude of the Japanese people toward the war and the decision of the Japanese government to surrender. It reaffirmed the substantial adverse impact the bombs had on the morale of the local inhabitants of

[53] See CINCAFPAC Msgs, 23 Sep and 18 Oct 45, HRC Files, 471.6 (Bombs, Atomic), CMH; Telecons, Ruth Markwood (Gen Ref Br, CMH) to Maj G. Chase (OCINFO, DA), sub: Names of Americans Killed by Hiroshima Atomic Bombing, 17 and 26 Apr 72, HRC Files, 384.5 (Aerial Attacks and Raids-Atomic Bomb), CMH; *Washington Post*, 11–12 Jul 70.

ATOMIC BOMBING CASUALTIES AT NAGASAKI

Hiroshima and Nagasaki. But the USSBS found that, in the relatively brief period between the dropping of the bombs and the start of surrender negotiations, people elsewhere in Japan had "neither time nor understanding of the revolutionary threat of the atomic bomb . . . to see in [them] a final blow to Japan's prospects for victory or negotiated peace." [54] The USSBS concluded also that, while the bombs had some impact on the leaders of the Japanese government, their knowledge of the awesome character of the new weapon seems not to have played a significant part in convincing them of the need to surrender.

The USSBS and virtually all the other survey groups that inspected the results of the attacks on Hiroshima and Nagasaki agreed with the Manhattan teams' assessment that the atomic bomb was indeed a revolutionary new device capable of inflicting damage and casualties on a scale far beyond any existing weapon available for use in modern warfare. The one dissent to this view among the survey groups came from Major de Seversky, who had made a hurried one-man inspection of Hiroshima and Nagasaki in the fall of 1945. He contended that the other survey groups had greatly exaggerated the effects of the bombs and misinterpreted the character of the destruction they had wrought. He asserted that about 200 B–29's loaded with incendiaries could have accomplished an equivalent amount of damage. Furthermore, he argued, atomic bombs dropped on modern cities, such as New York or Chicago, would do no more damage than a 10-ton blockbuster. The wide circulation of de Seversky's conclusions in newspapers and the publication of his article, "Atomic Bomb Hysteria," in the February 1946 issue of *Reader's Digest* created a public controversy. As a result, the Senate Special Committee on Atomic Energy, at work on preparing legislation for the peacetime control of the new energy source, invited de Seversky and representatives of the Manhattan Project, the USSBS, and other appropriate organizations to present their views at its 15 February session.[55]

[54] USSBS, *The Effects of Atomic Bombs on Hiroshima and Nagasaki*, p. 22.

[55] *Atomic Energy Hearings on S. Res. 179*, pp. 453–551. The Senate in late October 1945 had established a Special Committee on Atomic Energy to deal with "problems relating to the development, use, and control of atomic energy" (ibid., p. 1). De Seversky reported to the Secretary of War on the

Continued

SURVIVORS OF THE NAGASAKI BOMBING *returning to the devastated city*

Representing the Manhattan Project at the hearing were General Farrell and Colonel Warren. Farrell concentrated on refuting de Seversky's downgrading of the psychological and physical effects of the bombing of Japan. De Seversky, he said, underestimated the psychological damage created by the instantaneousness of an atomic explosion and the lack of any effective defense against it. He challenged the accuracy of de Seversky's data on the comparative damage possible with conventional air weapons and stated that the evidence collected by the Manhattan survey teams indicated that at least 703 B-29's would be required to do the physical damage caused by the atomic bomb at Hiroshima. While expressing concern with the popular tendency to overestimate the power of the bombs, Farrell asserted that "if two bombs will do what was done to Hiroshima and Nagasaki, put two cities out of commission and stop a war, I think it is [*sic*] a fairly effective weapon." [56]

Colonel Warren generally supplemented General Farrell's testimony on the extensive physical damage, caused by fire and the blast effect, in Hiroshima and Nagasaki. He emphasized especially the difficulty of arriving at any accurate conclusions on what had actually happened on the

results of his study of air power in the Pacific Theater in a letter dated 11 February 1946. That part of the letter which relates to the atomic bombing of Japan is reproduced in ibid., pp. 493–501.

[56] Testimony of Farrell in ibid., p. 505.

basis of observations made and information gathered in the period of a few days of hurried inspection, such as that carried out by Major de Seversky. He cited, for example, the impossibility of arriving at an accurate estimate of casualties without a great deal more investigation and analysis, as the Japanese themselves were not able to furnish reliable statistics. Because of confusion, shock, and panic, Japanese medical officials had not kept adequate records of mortalities and injuries caused by the bombs. Colonel Warren reinforced General Farrell's conclusion "that a tremendous amount of destruction occurred" and the atomic bomb had accomplished "the job it was intended to do." [57]

For the most part representatives of the USSBS and other experts supported the views expressed by Farrell and Warren. In the face of almost unanimous disagreement, de Seversky persisted in his contention that a Hiroshima-type atomic bomb was not any more effective against the stone, concrete, and brick structures in Western cities than a well-placed 10-ton blockbuster. He did concede, however, that a final understanding of the potentialities of atomic bombs as weapons of war would be possible only after a much more thorough and careful investigation and analysis of their effects on Hiroshima and Nagasaki.

Personnel of the Manhattan Project had participated in almost every aspect of the planning and preparations for employment of atomic bombs against Japan: in the decision to use the bombs against Japanese cities; in the choice of targets; in the development of an overseas base; and, finally, in the assessment of the damage wrought. The destruction of Hiroshima and Nagasaki marked their efforts with complete technical success and contributed significantly to ending World War II. Yet the respite that the project's success had afforded was momentary, for looming on the horizon was another threat to the security of the nations of the world—how to control this revolutionary new force in a peacetime environment. In face of this profound problem, the Manhattan Project would continue to operate in the emerging postwar period and its personnel would assume a role in guiding the domestic and international efforts to ensure that atomic energy would best serve the needs of mankind.

[57] Testimony of Warren in ibid., p. 513.

Appendix—Einstein's Letter

Albert Einstein
Old Grove Rd.
Nassau Point
Peconic, Long Island
August 2d, 1939

F. D. Roosevelt
President of the United States
White House
Washington, D.C.

Sir:

Some recent work by E. Fermi and L. Szilard, which has been communicated to me in manuscript, leads me to expect that the element uranium may be turned into a new and important source of energy in the immediate future. Certain aspects of the situation which has arisen seem to call for watchfulness and, if necessary, quick action on the part of the Administration. I believe therefore that it is my duty to bring to your attention the following facts and recommendations.

In the course of the last four months it has been made probable—through the work of Joliot in France as well as Fermi and Szilard in America—that it may become possible to set up a nuclear chain reaction in a large mass of uranium, by which vast amounts of power and large quantities of new radium-like elements would be generated. Now it appears almost certain that this could be achieved in the immediate future.

This new phenomenon would also lead to the construction of bombs, and it is conceivable—though much less certain—that extremely powerful bombs of a new type may thus be constructed. A single bomb of this type, carried by boat and exploded in a port, might very well destroy the whole port together with some of the surrounding territory. However, such bombs might very well prove to be too heavy for transportation by air.

The United States has only very poor ores of uranium in moderate quantities. There is some good ore in Canada and the former Czechoslovakia, while the most important source of uranium is the Belgian Congo.

In view of this situation you may think it desirable to have some permanent contact maintained between the Administration and the group of physicists working on chain reactions in America. One possible way of achieving

this might be for you to entrust with this task a person who has your confidence who could perhaps serve in an unofficial capacity. His task might comprise the following:

a) to approach Government Departments, keep them informed of the further development, and put forward recommendations for Government action, giving particular attention to the problems of securing a supply of uranium ore for the United States.

b) to speed up the experimental work, which is at present being carried on within the limits of the budgets of University laboratories, by providing funds, if such funds be required, through his contacts with private persons who are willing to make contributions for this cause, and perhaps also by obtaining the co-operation of industrial laboratories which have the necessary equipment.

I understand that Germany has actually stopped the sale of uranium from the Czechoslovakian mines which she has taken over. That she should have taken such early action might perhaps be understood on the ground that the son of the German Under-Secretary of State, von Weizaecker, is attached to the Kaiser-Wilhelm-Institut in Berlin where some of the American work on uranium is now being repeated.

Yours very truly,[1]
(signed) *A. Einstein*

[1] Original of letter and inclosures filed in FDR.